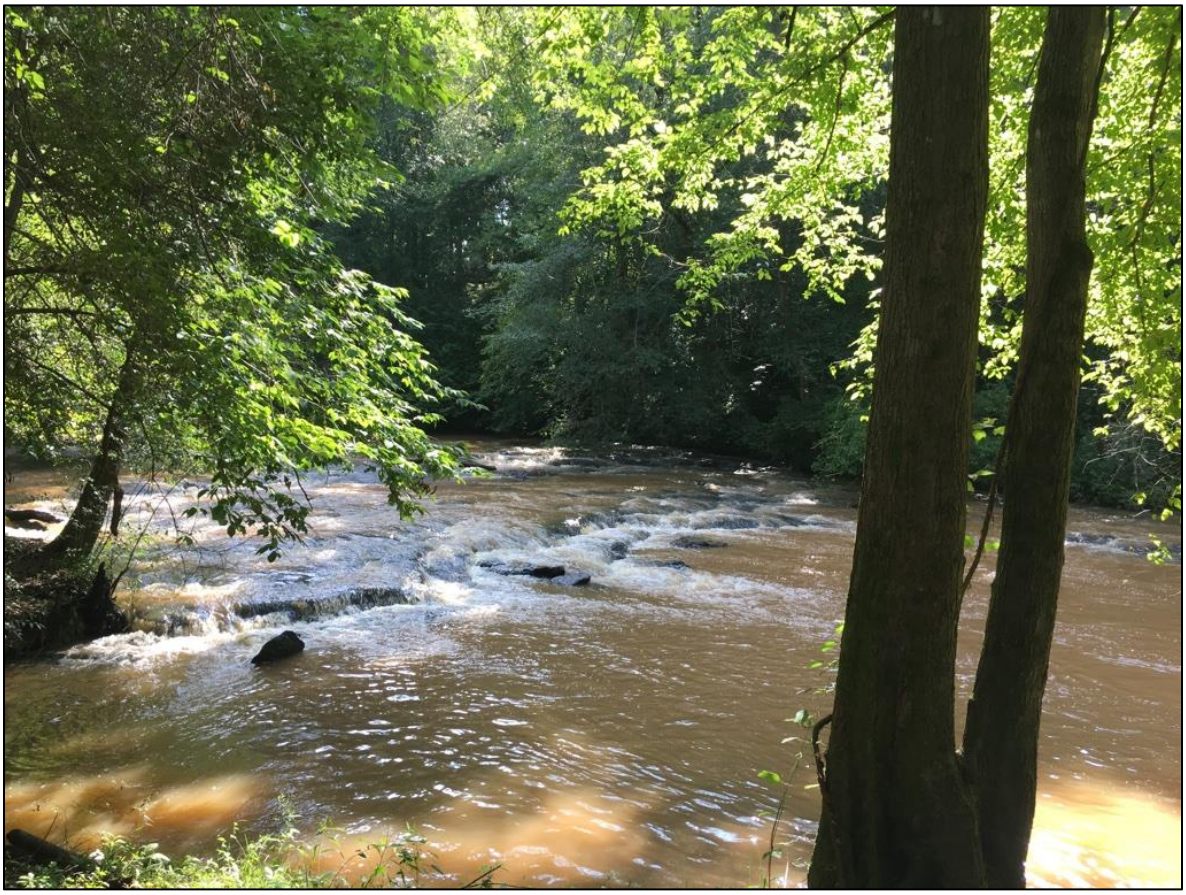
Watershed-Based Plan for the Three and Twenty Creek Watershed

An Action Plan for Protection and Restoration Activities



Prepared by

UPSTATE FOREVER

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for SCDHEC

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Project Stakeholders

- Anderson County Stormwater Department
- Anderson Regional Joint Water System (ARJWS)
- Anderson and Pickens Counties Stormwater Partners (APCSP)
- Lake Hartwell Association (LHA)
- Pickens County Stormwater Department
- Three and Twenty Watershed District

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LIST OF ACRONYMS

AL	Aquatic Life
APCSP	Anderson and Pickens County Stormwater Partners
ARJWS	Anderson Regional Joint Water System
AWEP	Agricultural Water Enhancement Program
BIO	Biological [Water Quality Criteria]
BOD	Biochemical Oxygen Demand
BMP	Best Management Practice(s)
CAFO	Concentrated Animal Feeding Operation
CFU	Colony Forming Unit
CLM	UF's Critical Lands Map
CRP	Conservation Reserve Program
CSP	Conservation Steward Program
CU	Clemson University
Cu	Copper (atomic symbol)
CWA	UF's Critical Watershed Area
ECHO	U.S EPA's Enforcement and Compliance History Online
E. coli	*Escherichia coli* (Bacteria)
ECU	Easley Combined Utilities
EQIP	Environmental Quality Incentive Program
FC	Fecal Coliform
FEMA	Federal Emergency Management Agency
FSA	Farm Service Agency
FW	Fresh Water
gSSURGO	Gridded Soil Survey Geographic Database
HUC	Hydrologic Unit Code
IN DNR	Indiana Department of Natural Resources
InVEST	Integrated Valuation of Ecoststem Services and Trade-offs (model)
LA	Load Allocation

LHA	Lake Hartwell Association
mL	Milliliter
MOS	Margin of Safety
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer System
MSL	Mean Sea Level
MST	Microbial Source Tracking
ND	No Discharge
NHD	National Hydrography Dataset
NLCD	National Land Cover Dataset
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
Pb	Lead (atomic symbol)
RUSLE	Revised Universal Soil Loss Equation
SC AAS	South Carolina Adopt-A-Stream
SCDHEC	South Carolina Department of Health and Environmental Control
SCDNR	South Carolina Department of Natural Resources
SMP	Shoreline Management Plan
SSO	Sanitary Sewer Overflow
STEPL	Spreadsheet Tool for Estimating Pollutant Loads
STORET	U.S EPA's Water Quality Storage and Retrieval Data Warehouse
SWCD	Soil and Water Conservation District
SWPA	Source Water Protection Area
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
UF	Upstate Forever
USDA	United States Department of Agriculture

U.S EPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USLE	Universal Soil Loss Equation
WBP	Watershed-Based Plan
WCO	Wildlife Control Operator
WHIP	Wildlife Habitat Incentives Program
WLA	Waste Load Allocation
WQMS	Water Quality Monitoring Station

EXECUTIVE SUMMARY

The Three and Twenty Creek Watershed (Hydrologic Unit Code: HUC 03060101-07) is a 105,765 acre watershed located in the upper portion of the Savannah River Basin in Anderson and Pickens Counties. The watershed drains to Lake Hartwell, which serves as a drinking water supply for Anderson Regional Joint Water System (ARJWS), serving over 200,000 residents in Anderson and Pickens Counties. Five of ARJWS's intake pumps are located at the Six and Twenty Creek mouth of Lake Hartwell within the Three and Twenty Creek Watershed.

This watershed-based plan (WBP) addresses sources of bacteria, sediment, and nutrient pollution and identifies critical areas for protection and restoration throughout the watershed. Additionally, this plan provides strategies to reduce or eliminate pollution loads, recommends potential funding opportunities and technical resources for pollution mitigation practices, and outlines a public outreach strategy to increase public awareness about water quality issues as it relates to bacteria, sediment, and nutrients.

Pollutants and Sources: In 2005, a Fecal Coliform (FC) Bacteria Total Maximum Daily Load (TMDL) for the Eighteen Mile Creek, Three and Twenty Creek, Little River and Long Cane Creek Watersheds in the Savannah River Basin, South Carolina was approved by the U.S. Environmental Protection Agency (U.S EPA) and identified the maximum amount of bacteria the Three and Twenty Creek watershed could receive while still meeting state water quality standards. According to the 2016 SCDHEC 303(D) List of Impaired Waters, one active ambient water quality monitoring station within this watershed (SV-111) is not attaining water quality standards for bacteria. Primary sources of bacteria in this region are faulty septic systems, agricultural activities, pet waste, and wildlife. In addition, two water quality monitoring stations were listed as impaired for biological criteria, pointing to nutrient and sediment impariments, with development and urban activies, agricultural activies, waste water, and industrial discharges as primary sources of pollution.

Pollutant Load Reductions: To address the pollutants of concern, Upstate Forever (UF) analyzed necessary load reductions and possible sources of pollution, as well as the total possible annual load reductions based on current conditions, as outlined in Sections 6-7 (see Table 1). The needed load reductions are based on the total pollutant loading estimated within the watershed, while total load reductions possible are based on the amount of pollution that would be removed if all of the estimated pollutant sources were repaired or restored.

Table 1. Pollutant Load Reductions Needed in the Three and Twenty Creek Watershed

Pollutant of Concern	Load Reductions Needed	Load Reductions Possible
Bacteria	1.68E+14 counts/year	7.54E+15 counts/year
Sediment	11,295 tons/year	2,616,522 tons/year
Nutrients	635,114 lbs/year	296,781,975 lbs/year

Pollutant Load Reduction Recommendations: Next, UF recommended achievable strategies to reach necessary pollutant load reductions through the implementation of land protection, septic system repair/replacements, agricultural Best Management Practices (BMPs), wetland and riparian buffer restoration/enhancement, stormwater BMPs, shoreline management, voluntary dam removal, pet waste stations, and wildlife BMPs. Table 2 outlines the approximate number of BMPs recommended to achieve the necessary annual pollutant reductions. These estimations were derived using the standard annual pollutant removal rates for each BMP (see Appendix C and D) multiplied by the suggested number of BMPs in the watershed to attain the needed reductions. The four primary BMPs recommended for implementation throughout the watershed are septic repair/replacement, agricultural BMPs (e.g., exclusion fencing, heavy use areas, stream crossings), land protection, and riparian buffer restoration. With load reduction data and cost estimates available, these five BMPs will successfully and efficiently meet the recommended load reductions within the watershed.

Table 2. Recommended BMPs and Anticipated Annual Load Reductions in the Three and Twenty Creek Watershed

BMP	# of Projects	Bacteria Load Reduction (counts/year)	Sediment Load Reduction (tons/year)	Nutrient Load Reduction (lbs/year)	Total Cost Estimate
Septic Repair/ Restoration	60	1.45E+12	n/a	2,598	$240,000
Agricultural BMPs bundle	12	1.94E+14	48	312	$231,984
Pet Waste Stations	5	1.10E+13	n/a	n/a	$1,500
Land Protection	55 (acres)	n/a	11,259	1,276,000	$1,278,750
Riparian Buffer Restoration	5	n/a	0.13	6,925	$263,575
Total		**2.07E+14 counts/year**	**11,306.5 tons/year**	**1,285,835 lbs/year**	**$2,015,809**

Prioritizing BMP Installation Locations: Using the identified load reductions needed for each pollutant of concern and strategies to achieve those pollutant load reductions, UF conducted an in-depth Geographic Information Systems (GIS) land prioritization analysis at a parcel-by-parcel level for nine categories of protection and restoration strategies in order to most efficiently recommend where pollutant load reduction projects should be located. While nine categories were analyzed, final recommendations focused primarily on the BMPs listed in Table 2. UF used weighted criteria to analyze each parcel within the Three and Twenty Creek Watershed to identify priority lands for protection (i.e., protecting lands that would, if developed, have the biggest [negative] impact on water quality), restoration/enhancement (i.e., restore lands that are attributing to current pollutant loads or would provide significant water quality benefits if restored), and/or best management practices (i.e., water pollution mitigation practices). Each criterion was assigned a total number of possible points based on its importance to water quality protection or restoration. The results identify lands that should be protected or improved to provide the most benefit to water

quality. This analysis resulted in the creation of detailed GIS layers for each protection/restoration strategy. These data layers will allow for targeted implementation of projects in areas of the watershed that will yield the most positive water quality impacts and aid in achieving pollutant load reductions needed by targeting lands best suited for the recommended strategies.

WBP Implementation: UF developed a targeted public outreach and education strategy and project implementation timeline that details how to employ this plan in the future. Building on the success of current partnerships within the watershed, UF recommends utilizing the results of the land prioritization analyses to inform required BMP implementation (to meet load reductions) and target public outreach efforts within the watershed. Supplemental BMPs can be added to each phase as funding and resources allow. Taking advantage of the successful network of engaged partners and stakeholders will greatly enhance the success of BMP and public outreach strategy implementation and lead to the long-term quality of Lake Hartwell as a healthy public drinking water supply. Table 3 below details the estimated on-the-ground project cost of each phase.

Table 3: WBP Implementation Overview

	BMP	**Phase 1 (3 years)**	**Phase 2 (3 years)**	**Phase 3 (4 years)**	**BMP Project Goal**
Required BMPs	Land Protection	Landowner outreach	1-2 conservation easements		1-2 conservation easements, or 55+ acres of land protected
	Septic Repairs	20 repairs/ replacements	20 repairs/ replacements	20 repairs/ replacements	60 septic tank repairs or replacements
	Agricultural BMPs	4 projects	4 projects	4 projects	12 agricultural projects
	Riparian Buffer Restoration	Landowner outreach, Buffer ordinance improvement	2 projects	3 projects	5 riparian buffer restoration projects, strengthened buffer ordinances
	Pet Waste Stations	3 installations	2 installations		Install 5 pet waste stations at parks or pet-related businesses
Supplemental BMPs	Wetland Restoration	Monitor potential impacts, recommend mitigation	Monitor potential impacts, recommend mitigation	Monitor potential impacts, recommend mitigation	List of possible wetland mitigation locations and interested landowners
	Shoreline Management	Data collection of current conditions	Landowner outreach, SMP enforcement	Landowner outreach, SMP enforcement	Enforcement of the Shoreline Management Plan (SMP)
	Stormwater BMPs	Identify project needs, review of current regulations	Landowner outreach, strengthen regulations	BMP demonstration site and project installations	Strengthen stormwater regulations outside of MS4's, 1-2 BMP demonstration sites
	Wildlife BMPs	Identification of problem areas	Landowner outreach	Landowner outreach	Improved wildlife management

Summary: Bacteria, nutrients, and sedimentation are the primary pollutants of concern in the Three and Twenty Creek Watershed. Excess pollution can cause diminished drinking water quality

and incur significant costs to utilities and customers. To address pollution in the Three and Twenty Creek watershed, UF recommends a ten-year, three-phase implementation of this WBP to achieve needed load reductions that will cost an estimated $2,015,809 in on-the-ground project installations.

1) INTRODUCTION

Upstate Forever (UF), in collaboration with project partners (see Appendix A), developed the Three and Twenty Creek Watershed Watershed-Based Plan (WBP) for the (Hydrologic Unit Code: HUC 03060101-07) in the greater Seneca River Watershed (HUC 03060101) to reduce bacteria levels, sediment, and nutrient pollution from nonpoint sources in these waterways. The Three and Twenty Creek Watershed includes a source water intake and source water protection areas for Anderson Regional Joint Water System (ARJWS), a local water utility, which provides drinking water to over 200,000 customers living in Anderson and Pickens Counties.

In 2005 a Fecal Coliform Bacteria TMDL for the Eighteen Mile Creek, Three and Twenty Creek, Little River and Long Cane Creek Watersheds in the Savannah River Basin, South Carolina was approved by the U.S. Environmental Protection Agency (U.S EPA). According to the TMDL, the suspected nonpoint sources of bacteria in the region included urban runoff, failing septic systems, domesticated animals, wildlife, animal feeding operations, and agricultural runoff (SCDHEC, 2005). Sedimentation is also a concern in the region because it can degrade the quality of drinking water resources while adversely impacting aquatic organisms by destroying habitat and clogging fish gills. In fact, three South Carolina Department of Environmental Control (SCDHEC) monitoring stations in this area are impaired for Biological Criteria in this watershed. SCDHEC monitoring stations SV-735, RL-01020, and RS-03506 have been listed on the Section 303(d) List of Impaired Waters for aquatic life from 2008-2016, 2004-2016, and 2006-2016, respectively (2017, https://gis.dhec.sc.gov/watersheds/).

Since 2013, ARJWS has experienced periods of significant taste and odor problems in their drinking water. The taste and odor problems have been attributed to 2-methylisoborneol (MIB) and geosmin, two compounds produced as a by-product of algal blooms (ARJWS, 2017). It is especially problematic for drinking water providers because MIB and geosmin can be detected at 10 ng/L, an extremely low concentration. Levels of MIB and geosmin tend to peak during the warmer summer months, when algal concentrations are at their highest. Although ARJWS has conducted periodic lake treatments to control the algae, they did not view this as a sustainable mitigation option to reduce algal blooms in Lake Hartwell. As a result, in 2018 ARJWS upgraded their treatment plant to provide a more advanced oxidation process that aids in taste and odor removal from their drinking water at an installation cost of $13M (Mayo, 2017).

Future land use predictions for Anderson County suggest a high potential for growth in the residential, commercial, and industrial sectors. According to the Shaping Our Future Growth Analysis, approximately 155,651 acres of land in Anderson County will be consumed in the next 25 years (CityExplained, 2017; Urban 3, 2017). With the anticipated increase in land development and population within this watershed, it is crucial that we develop a plan for cost-effective strategies to protect and improve this important water supply.

To address these pollution issues, this WBP provides a comprehensive overview of the sources of bacteria, sediment, and nutrient pollution in this watershed and identifies critical areas for protection and restoration. This plan also provides strategies to reduce or eliminate pollution loads, recommends potential funding opportunities and technical resources for pollution mitigation practices, and outlines a public outreach strategy and water quality monitoring program as it relates to bacteria, sediment, and nutrients. Project partners for this WBP include: Anderson Regional Joint Water System (ARJWS), Anderson County Stormwater Department, Anderson and Pickens Counties Stormwater Partners (APCSP), Lake Hartwell Association (LHA), Pickens County Stormwater Department, and the Three and Twenty Watershed District.

2) GENERAL WATERSHED INFORMATION

2.1) Watershed Summary

This WBP focuses on the Three and Twenty Creek Watershed (HUC 0306010107) of the Seneca River Watershed (HUC 03060101) Basin. The Seneca River Watershed is contained within the upper portion of the Savannah River Basin. The portion of the Savannah River Basin inside South Carolina encompasses 3,171,462 acres and is subdivided into 34, 10-digit HUC watersheds that flow from the Blue Ridge and Piedmont regions of the state to the Sandhills, the Upper and Lower Coastal Plain, and Coastal Zone regions. The Three and Twenty Creek HUC 10 Watershed is divided into four 12-digit HUC subwatersheds (Table 4). Within the Three and Twenty Creek Watershed there are a total of 399 stream miles, all of which are classified as Fresh Waters (FW), 4,308 acres of lake waters, and over 105,000 acres of land (SCDHEC, 2017; SC Watershed Atlas, 2017) (Table 1).

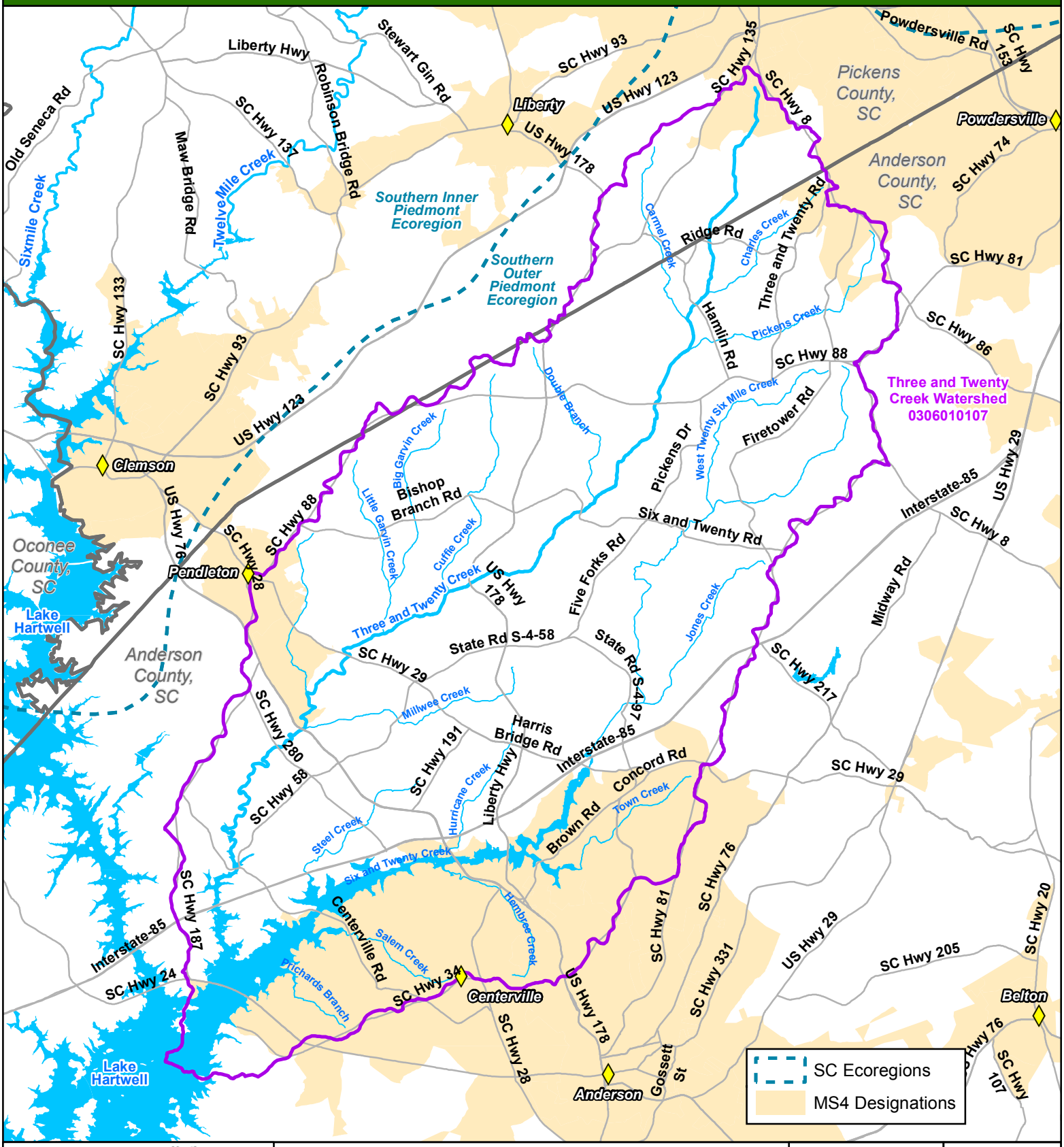
Table 4. Three and Twenty Creek Watershed Characteristics (SCDHEC, 2010, NLCD, 2011, National Hydrography data, 2016)

Subwatersheds	HUC Codes (acres)	Land (acres)	Streams (miles)	Lake (acres)
Upper Three and Twenty Creek	030601010701	29,942	108	154
Lower Three and Twenty Creek	030601010702	28,880	110	836
Upper Six and Twenty Creek	030601010703	19,194	79	41
Lower Six and Twenty Creek	030601010704	27,912	102	3,277
Total		105,765	399	4,308

2.2) Location and Hydrology

The Three and Twenty Creek Watershed is located within Anderson and Pickens Counties and in the Piedmont Ecoregion of South Carolina (Figure 1). The Piedmont Ecoregion is an area characterized by gently rolling to hilly slopes and narrow stream valleys dominated by forests, farms, and orchards. Elevations in this area range from 375 to 1,000 feet. The Three and Twenty Creek originates near the City of Easley and accepts drainage from Charles Creek, Carmel Creek, Pickens Creek, Double Branch, Cuffie Creek, Big Garvin Creek (Bishop Branch, Little Garvin Creek), Town Creek, and Millwee Creek. Six and Twenty Creek accepts drainage from Jones Creek, Town Creek, Hembree Creek, Hurricane Creek, Steel Creek, Salem Creek, and Prichards Branch before merging with Three and Twenty Creek to form Deep Creek, which flows into the Seneca River within Lake Hartwell (SCDHEC, 2010).

Figure 1: Three and Twenty Creek Watershed



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2.3) Population

The Three and Twenty Creek Watershed includes the communities of Pendleton, Northlake, Centerville, La France, Sandy Springs, Denver, Ashley Downs, and the City of Anderson (Figure 1). Population estimates for the area were calculated by identifying the U.S. Census Tracts within each HUC-12 subwatershed, and the total number of occupied homes data within the Census Tracts as provided by the U.S. Census. The estimated cumulative population of all four HUC-12 subwatersheds is 41,517, based on the number of occupied homes (16,825) and the average household size per US Census block group from the 2010 U.S. Census (U.S. Census Bureau, 2018).

Formula 1: Estimated Total Population in the Watershed

Estimated Population in Subwatersheds	=	Number of Occupied Homes	x	Average Household Size

2.4) Climate

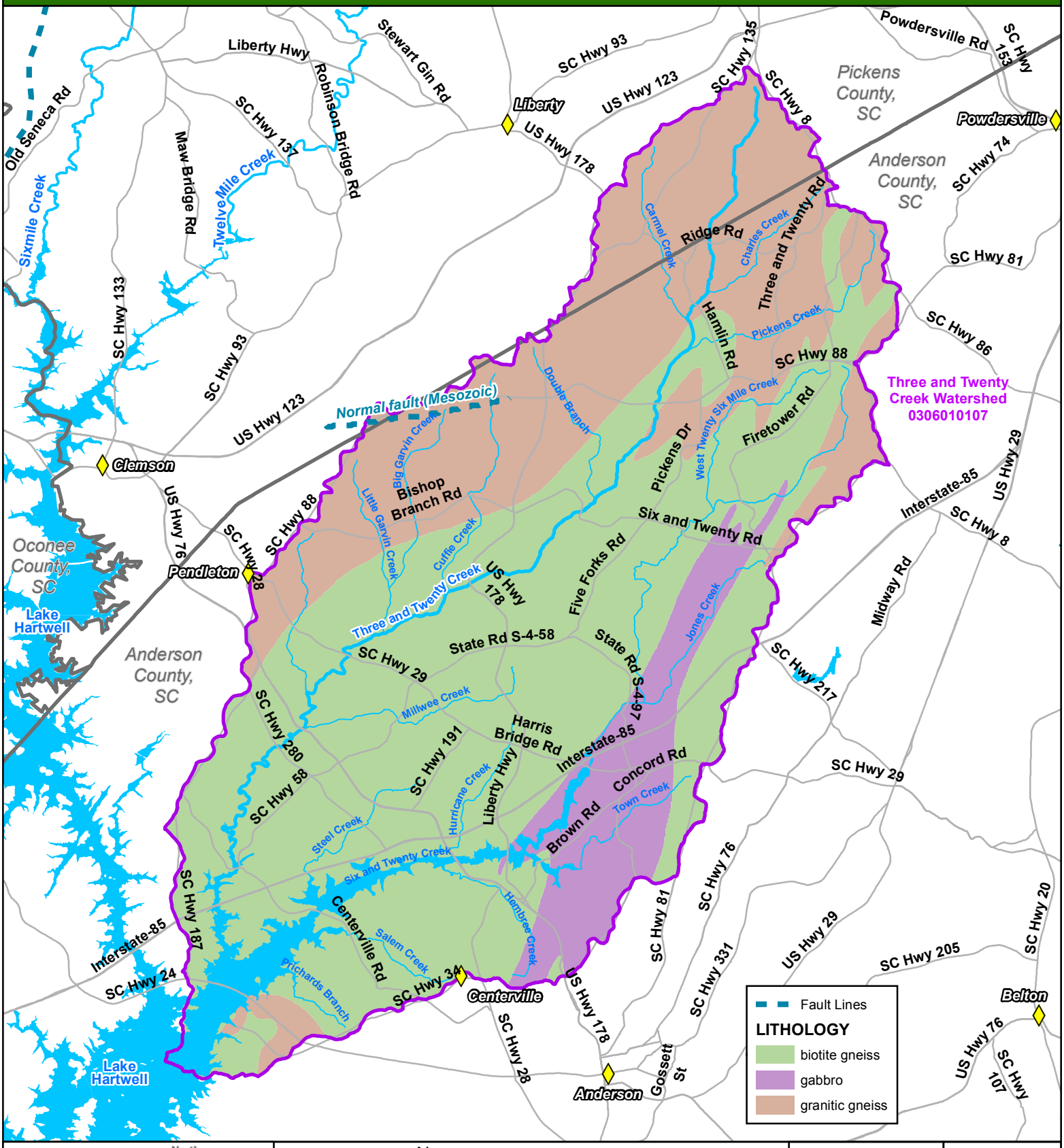
The watershed enjoys a moderate climate and is situated at roughly 34°N latitude and -82°W longitude. The annual mean temperature for the region is 61.0°F, with average temperatures ranging from 15°F–99°F (NOAA, 2018). Since the beginning of the 20th century however, temperatures in the state have increased 0.5°F (NOAA, 2018). Average annual rainfall throughout the watershed is 53.3 inches, while annual precipitation for the state of South Carolina has been below average during most of the 2000's (12 of 16 years during 2000 –2015) (U.S. Climate Data, 2017). Notably, since the start of the 21st century, the state has experienced a below normal number of extreme precipitation events (NOAA, 2018). As development and emissions in the region continue to rise, historically unprecedented warming is projected by the end of the 21st century, including increases in extreme heat events, and increased intensity of naturally occurring droughts (NOAA, 2018).

2.5) Geology and Soils

The primary geological feature of the watershed is the Six Mile thrust sheet (SCNDR, 2017) (Figure 2). The Six Mile thrust sheet is made up of number of rock types (e.g., mica, schist, red-weathering biotite schist, gneiss) that are commonly deeply weathered. The rocks were formed from sediments deposited in an environment containing volcanic materials (Nelson, 1998).

The principal soils within the focus area include Ashe, Cecil, Hayesville, Hiawassee, Madison, Pacolet and Saluda. The Soil K-factor, the soil erodibility factor, for the soils in this watershed ranges from 0.21 to 0.26 (SCDNR, 2016). K-values closer to 1.0 indicate higher soil erodibility and greater need for protection measures. Overall, the soils found in this watershed are well-drained, moderately permeable soils.

Figure 2: Lithology



2.6) Land Use and Land Cover

Sourced from the 2011 National Land Cover Dataset (NLCD), land cover in the focus area has been divided into eight categories, as shown in Table 4. Combined, the top three land cover classes are forest, developed land, agricultural. Forestland is the predominant land cover type across the watershed, covering 36% of the total watershed's area (Figures 3 and 4). Developed land accounts for 21% of the watershed's land cover and is concentrated around the cities and major transportation corridors (e.g., Hwy 178, I-85, Hwy 280, Hwy 34, Hwy 28), particularly in the lower portion of the watershed. In this plan pasture/hay and cultivated crops are considered agricultural lands, and account for 10% of the land area in the watershed. Agricultural land is most prominent around the Three and Twenty Creek, particularly in the middle and northern portions of the watershed.

Table 5. Primary Land Cover Classes Three and Twenty Creek Watershed

Land Cover Type	Three and Twenty Creek (Acres)
Open Water	4,308
Developed Land	22,530
Barren Land	649
Forest	37,537
Shrub/Scrubland	863
Pasture/Hay	28,181
Herbaceous Natural	10,609
Cultivated Crops	163
Wetlands	1,089
Total	105,929

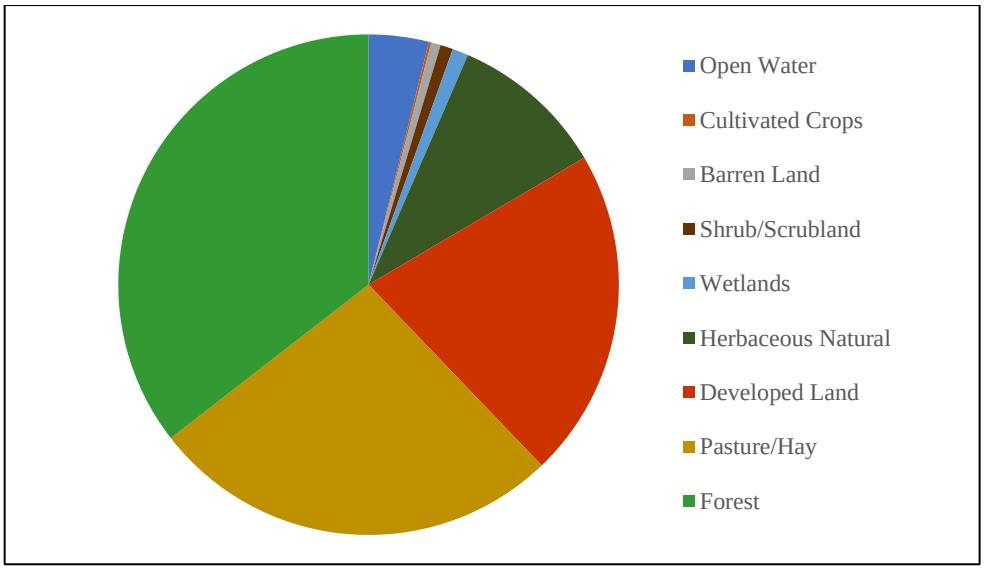
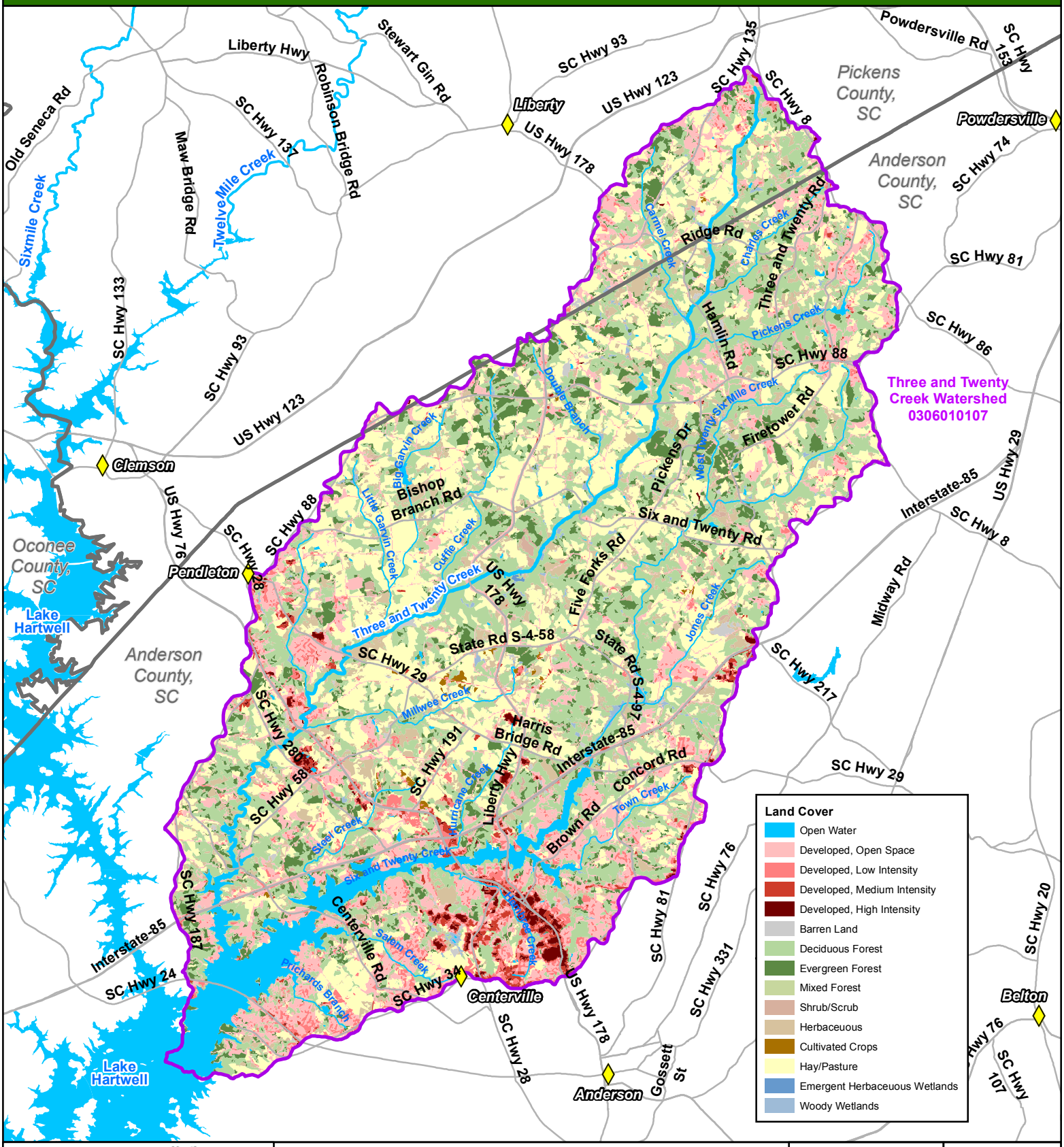


Figure 3. Land Cover Classifications for Three and Twenty Creek Watershed

Figure 4: Land Cover



2.7) Source Water Intakes

ARJWS obtains its source water from the U.S. Army Corps - operated Lake Hartwell Reservoir, and provides drinking water to over 200,000 residents within Anderson and Pickens counties. ARJWS manages five intake pumps that are located on Six and Twenty Mile Creek and one main source water intake, S04101, located on the Deep Creek arm of Lake Hartwell (SCDHEC SC Watershed Atlas, 2018). Additionally, a source water protection area width of 1,500 buffer feet has been designated for the utility to provide more protection to these important drinking water sources. The protection area includes sections of Six and Twenty Creek, Jones Creek, Hurricane Creek, and the Deep Creek arm of Lake Hartwell (Figure 4).

2.8) Benefits of Watershed-Based Plans

Watershed-based plans enhance source water protection planning efforts by delineating all potential impacts to source waters within an entire watershed. Through a variety of strategies (e.g., land protection, agricultural BMPs, septic system repairs, improved riparian buffers) it is possible to reduce and/or prevent nonpoint source pollutants from washing off lands and contaminating our waterways and drinking water resources. Not only do these actions improve water quality, but also reduce treatment costs for utilities and ultimately their customers. WBPs outline specific actions and strategies for water quality protections and improvements that will help to ensure sustainable and safe drinking water supplies for our local communities.

3) WATER QUALITY MONITORING AND ASSESMENT

3.1) Water Quality Impairments and Sources

SCDHEC is entrusted with the responsibility of enforcing state water quality standards. These standards, R. 61-68 Water Classification and Standards, have been established to protect South Carolina's surface and groundwater resources. The purpose of this regulation is to create general rules, specific numeric and narrative criteria, and anti-degradation rules for the protection of classified and existing water uses and to establish procedures to classify waters of the State (SCDHEC, 2014).

3.2) Water Quality Monitoring Stations

SCDHEC strategically places water quality monitoring stations across the state of South Carolina to evaluate surface and groundwater water quality. Within Three and Twenty Creek there are a total of six, both active and inactive, SCDHEC water quality monitoring stations (Table 5). Currently, there is one regularly monitored station, and five inactive stations in the region. The data for these stations were collected and analyzed by SCDHEC from 1999 – 2018. These sites are sampled for a combination of water quality parameters including pollutants, macroinvertebrate populations, and special study sites that determine if, and to what extent, a wastewater discharge or nonpoint source runoff source is impacting its receiving stream (SCDHEC, Surface Water Monitoring) (Figure 5).

Table 6. SCDHEC Water Quality Monitoring Station (WQMS) Locations and Status

WQMS	WQMS Location	Type	Status
RL-01020	Lake Hartwell 6 miles NNW of Anderson	Ambient/Macro, Lake	Inactive
RL-12047	Lake Hartwell, Six and Twenty Creek arm 0.1 mi N of Darwin A. Wright park	Ambient, Lake	Inactive
RS-03506	Charles Creek at unnumbered Ridge Road off S-04-485	Ambient/Macro	Inactive 03*
SV-111	Three and Twenty Creek at S-04-280	Ambient, Base	Active
SV-181	Six and Twenty Creek at S-04-29, 8.2 Miles SE of Pendleton	Ambient, Historic	Inactive
SV-735	Three and Twenty Creek at SR 29	Special Study Site, Macro	96, 00, 05*

**Years macroinvertebrate sampling was conducted*

3.3) Bacteria Impairments

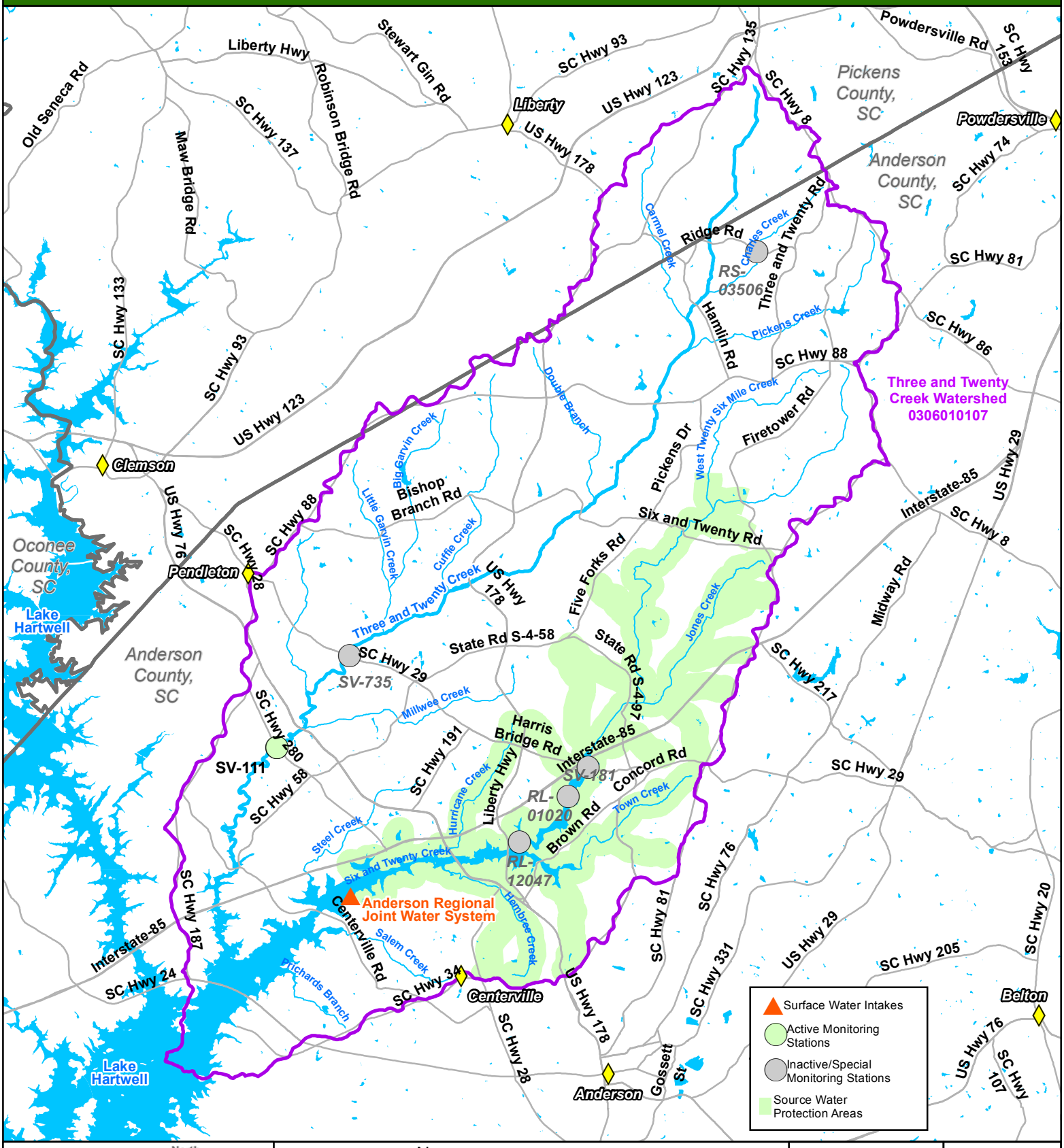
Prior to 2013, South Carolina used Fecal Coliform (FC) as the bacterial indicator to evaluate the safety of freshwaters for recreational purposes. The standard for FC was a maximum daily concentration of 400 Coliform Forming Units (CFU) per 100 milliliters (ml) of water and a 30-day geometric mean of 200 CFU per 100 ml. Water samples that exceeded this standard more than 10% of the time were considered impaired and unsafe for recreation. Sites considered impaired for FC were then placed on SCDHEC's biennial 303(d) list. In 2013 SCDHEC switched to the *Escherichia coli* (*E. coli*) as the bacterial indicator for freshwaters. The current SC standard for *E. coli* is a daily concentration not to exceed 349 MPN/100 ml and 30-day geometric mean of 126 MPN/100 ml. FC and *E. coli* are typically not a threat themselves to human health; however, their presence in freshwaters is indicative of fecal pollution in surface waters. Fecal contamination is considered a human health risk because it may contain disease-causing organisms such as pathogenic bacteria, viruses, protozoa, or parasites (U.S EPA, 1986).

Due to this relatively recent transition in bacteria standards, the majority of the available water quality data for the water quality monitoring sites in the focus area are recorded as FC. Consequently, in this watershed plan the bacteria load reductions were calculated using FC data and are referred to generically as "bacteria". Also, the monitoring plan in this Watershed-Based Plan is designed specifically to address *E. coli* bacteria.

3.4) Biological Impairments

Biological criteria include both narrative expressions and numeric values of the biological characteristics of aquatic communities based on appropriate reference conditions (SCDHEC, 2014). Biological criteria serve as an index of aquatic community health. There are several factors that can contribute to a stream being listed as biologically impaired. The primary stressors influencing stream biological integrity include sediment, habitat quality, dissolved oxygen, pH, metals, and nutrients.

Figure 5: Monitoring Stations, Intakes, and Source Water Protection



Legend

- Cities/Towns
- Roads
- HUC-10: 0306010107 (Three and Twenty)
- Lakes
- Streams
- Rivers/Creeks

N

0 0.75 1.5 3 4.5 6 Miles

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3.5) History of Water Quality

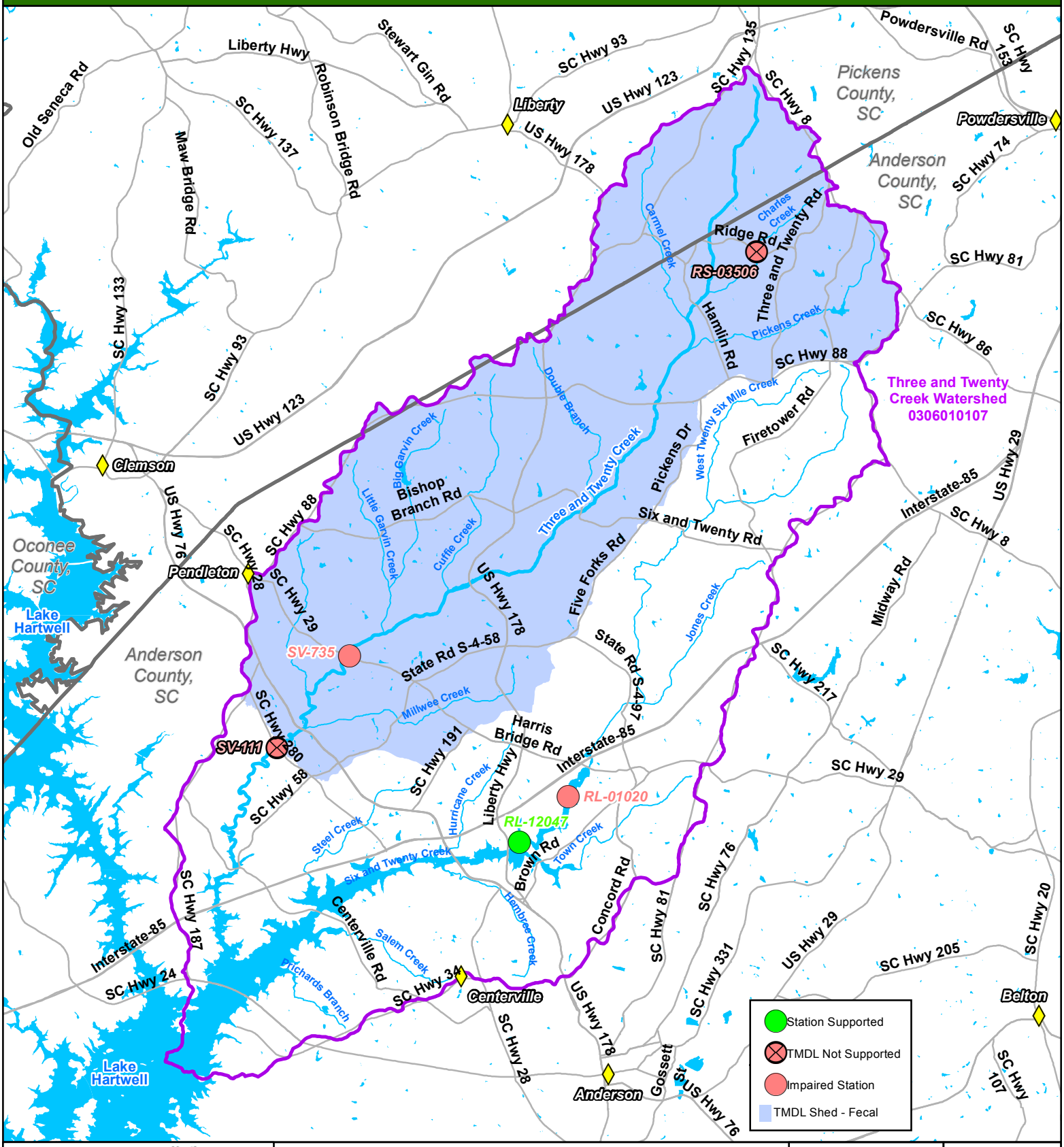
As shown in Figure 6, several tributaries within the focus area are listed as impaired due to high levels of bacteria, based on South Carolina's 2016 Section 303(d) of the Clean Water Act list of impaired or threatened waters. The 303(d) lists are compiled biannually by SCDHEC and provide information on waterbodies regarding their impairment status. An impaired water body can be removed from the 303(d) list by either attaining water quality standards, or by the approval of a TMDL. It is important to note that the approval of a TMDL does not ensure that water quality standards will be achieved. SCDHEC provides a status update of the TMDL sites every two years in a biennial report.

A TMDL for fecal coliform bacteria was approved for Eighteen Mile Creek, Three and Twenty Creek, Little River and Long Cane Creek Watersheds in the Savannah River Basin, South Carolina in 2005 (SCDHEC, 2005). This TMDL includes four HUC 10 watersheds: Eighteen Mile Creek, Three and Twenty Creek, Little River, and Long Cane Creek and 15 water quality monitoring stations. These water quality monitoring stations were impaired due to violations of the State's fecal coliform standard. One of these 15 monitoring stations (SV-111) is located within the Three and Twenty Creek Watershed and is included in this watershed plan (Table 6). According to the TMDL, the major sources of fecal bacteria in this area include urban runoff, failing septic systems, domesticated animals, wildlife, animal feeding operations, and agricultural runoff (SCDHEC, 2005). Sites that are listed as being in nonsupport of the TMDL have a percentage of exeedances greater than 25%.

Table 7. Bacteria Water Quality Impairments (SCDHEC 303(d) Lists From 1998-2016)

WQMS	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016
RL-01020	--	--	--	--	--	--	--	--	--	--
RL-12047	--	--	--	--	--	--	--	--	--	--
RS-03506	--	--	--	--	--	REC-FC	TMDL NS	TMDL NS	TMDL NS	TMDL NS
SV-111	REC-FC	REC-FC	REC-FC	REC-FC	--	--	--	TMDL NS	TMDL NS	TMDL NS
SV-181	REC-FC	REC-FC	REC-FC	--	--	--	--	--	--	--
SV-735	--	--	--	--	--	--	--	--	--	--

Figure 6: Impaired Waters



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As shown in Table 8, the highest fecal coliform sample was detected at site SV-111 in the Lower Three and Twenty Creek Watershed with a value of 15,000 CFU/100 ml. This site also reported the highest percent exceedance, 38.93%, which indicates that this site was over the state standard nearly 39% of the time; this site also has the highest average sample value of 700.2 CFU/100 ml. Percent Exceedance was based on the FC standard of 400 CFU/100 ml, meaning sites in excess of 400 CFU/100 ml were classified as an exceedance. Site RS-03506 has the second highest average value at 304.9 CFU/100 ml and is located in the Upper Three and Twenty watershed. Interestingly, this site had a much lower percent exceedance rate at nearly 17%. The maximum bacteria values for sites SV-111 and RS-03506 were significantly higher than the other remaining sites ranging from 2,400-15,000 CFU/100 ml.

Table 8. Fecal Coliform Results from SCHDEC Water Quality Monitoring Stations (U.S EPA STORET)

WQMS	Total Samples	Years	Average Sample*	Max Value*	Samples in Compliance	Exceedances	Percent Exceedances
RL-01020	10	2011	10.5	48	10	0	0%
RL-12047	12	2012	50.4	230	10	2	16.7%
RS-03506	12	2003	304.9	2,400	10	2	16.7%
SV-111	131	1999-2018	700.2	15,000	80	51	38.9%
SV-181	25	1999-2005	136.0	1,000	24	1	4.0%

**Average result and Maximum Value in CFU/100 ml.*

SCDHEC began collecting *E. coli* data in 2013 from one site within the focus area (Table 9). The state standard for *E. coli* is a daily maximum of 349 MPN/100 ml. Based on this information, 61% of the samples from B-018A continue to exceed state bacteria standards with a maximum value of 3,147 MPN/100 ml. Site B-332 was previously delisted from the Section 303 (d) lists from 2010-2014 was again listed as impaired in the 2016-303(d) list with a percent exceedance rate of 63%. Although the average samples for sites B-014 and B-332 were below the state standard, their percent exceedances where higher than 10%, thus leading to the addition of these sites to the 2016 303(d) list.

Table 9. *E.coli* Results from SCDHEC Water Monitoring Stations (U.S EPA STORET)

WQMS	Total Samples	Sample Years	Average Result*	Max Value*	Samples in Compliance	Number of Exceedances	Percent Exceedances
SV-111	29	2013-2018	399	1,413	16	13	44.8%

**Average result and Maximum Value measured in MPN/100 ml.*

Multiple water quality monitoring stations in the focus area have also been listed as impaired for biological criteria according to the State 303(d) lists (Table 10). Sites are added to the 303(d) list if they do not meet the Aquatic Life Use Support (AL) criteria designated by the State. According to SCDHEC, AL Use Support is determined by comparing important water quality characteristics to specific biological criteria. Support of AL is determined based on the percentage of criteria excursion and, where data are available, the composition functional integrity of the biological community. Core indicators include macroinvertebrate community conditions, dissolved oxygen (DO), pH, turbidity, nutrients, and heavy metals. If it is determined that for any one parameter that

the criterion is not met, then it is deemed that the AL use is not supported and the location is listed as impaired for AL (SCDHEC, 2018).

Table 10. Biological Water Quality Impairments as Reported by SCDHEC 303(d) Lists

WQMS	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016
RL-01020	--	--	--	AL-PH	AL-PH	AL-PH	AL-PH	AL-PH	AL-PH	AL-PH
RL-12047	--	--	--	--	--	--	--	--	-	--
RS-03506	--	--	--	--	AL-BIO	AL-BIO	AL-BIO	AL-BIO	AL-BIO	AL-BIO
SV-111	--	--	--	--	--	--	--	--	--	--
SV-181	--	--	--	--	--	--	--	--	--	--
SV-735	AL-BIO	AL-BIO	AL-BIO	--	--	AL-BIO	AL-BIO	AL-BIO	AL-BIO	AL-BIO

4) BACTERIA POLLUTION

4.1) Bacteria Pollution Sources

Bacterial pollution can be attributed to both point and nonpoint sources within the watershed. Potential sources of bacteria pollution in the focus area include agriculture land uses, wastewater effluent, urban runoff, and wildlife (Table 11).

Table 11. Potential Sources of Bacteria Pollution in the Focus Area

Agriculture	Wastewater	Urban	Wildlife
• Cattle • Horses • Sheep and Goats • Poultry • Cropland	• Septic Tanks • WWTPs	• Stormwater Runoff • Domestic Pets	• Deer • Feral Hogs • Waterfowl • Beavers

4.1.1) Point Sources of Bacteria Pollution

A point source pollutant is one that can be identified as a single or definite source. The National Pollution Discharge and Elimination System (NPDES) controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Major municipal dischargers include all facilities with design flows greater than one million gallons per day, while minor dischargers are less than one million gallons per day (U.S EPA, 2017). There are five NPDES permits in the region that are permitted to discharge bacteria into the watershed. These sites are listed in Table 12 (Figure 7). While no specific bacteria exceedances are noted, several facilities have had Clean Water Act compliance issues in the past 12 quarters. Harbor Gate Condominiums (SC0021849) spent the past four quarters dating from 07/01/2017- 07/31/2018 in noncompliance

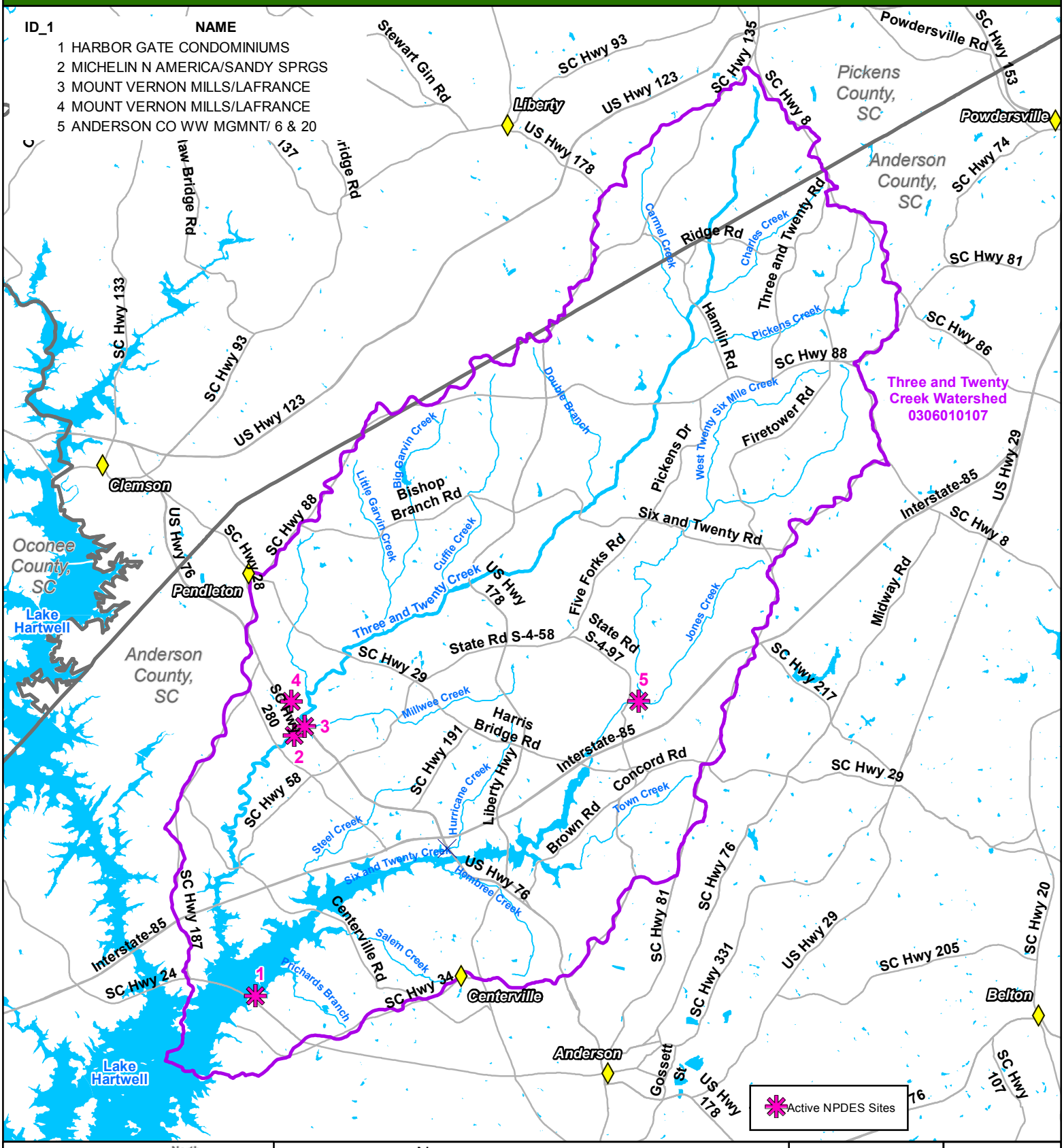
for Total Cadmium and Total Zinc exceedances. The Michelin NA Inc. Sandy Springs plant (SC0026701) has a history of noncompliance with eight quarters of violations in the past twelve for exceedances of Methylene Chloride. Mount Vernon Mills Inc La France Division (SC0000485) has had two quarters of noncompliance and one quarter of significant violation in the past twelve. These violations were for exceedances in *E. coli*, Chemical Oxygen Demand, and pH levels. Anderson County Six and Twenty Creek Wastewater Facility (SC0040193) also has experienced noncompliance issues. In the past twelve quarters the plant has received a rating of six quarters of noncompliance *E. coli* and Total Ammonia violations. Finally, the Jacabb Utilities LLC wastewater treatment plant (SCG570008) has experienced one recorded quarter of noncompliance in the previous twelve for exceedances in Biological Oxygen Demand (BOD). All NPDES information for these facilities was obtained from the following website https://echo.epa.gov/facilities/facility-search (U.S EPA ECHO, 2018).

Table 12. Permitted NPDES Sites in the Three and Twenty Creek Watershed

Map Id	NPDES Permit #	Facility Name	Facility Type	Permitted to Discharge Bacteria
1	SC0021849	Harbor Gate Condominiums WWTP	Domestic	Yes
2	SC0026701	Michelin NA America/Sandy Springs	Industrial	Yes
3	SC0000485	Mount Vernon Mills Inc/La France Industries Division	Industrial	Yes
4	SC0040193	Anderson County Six and Twenty Wastewawter Facility	Domestic	Yes
5	SCG570008	Jacabb Utilities LLC / The Shoals WWTP	Domestic	Yes

Wastewater Treatment Plants - Wastewater treatment plants (WWTPs) are considered a point source of bacteria pollution in this plan. There are three permitted WWTPs in the focus area (Figure 9 and Table 12). Occasionally, problems with wastewater treatment plants can occur, which may lead to sanitary sewer overflows (SSOs) that result in untreated sewage discharge into local waterways. SSOs can occur during both dry and wet weather conditions. Possible causes include: heavy rain events that overwhelm the pipes or system, blockages in the pipes, construction activities, and equipment failures. SCDHEC tracks SSO events that cause a health concern, reach a waterbody, or are estimated to exceed 500 gallons. SSOs are reported by SCDHEC as the net volume of wastewater lost to the environment (SCDHEC, 2018). According to SCDHEC there have been a total of 87 SSOs with an estimated cumulative volume of 515,997 gallons since January 2013 in Anderson County with a portion of these SSOs occurring in the focus area (SCDHEC, 2018) (http://www.scdhec.gov/apps/environment/SSO/).

Figure 7: Active NPDES Sites



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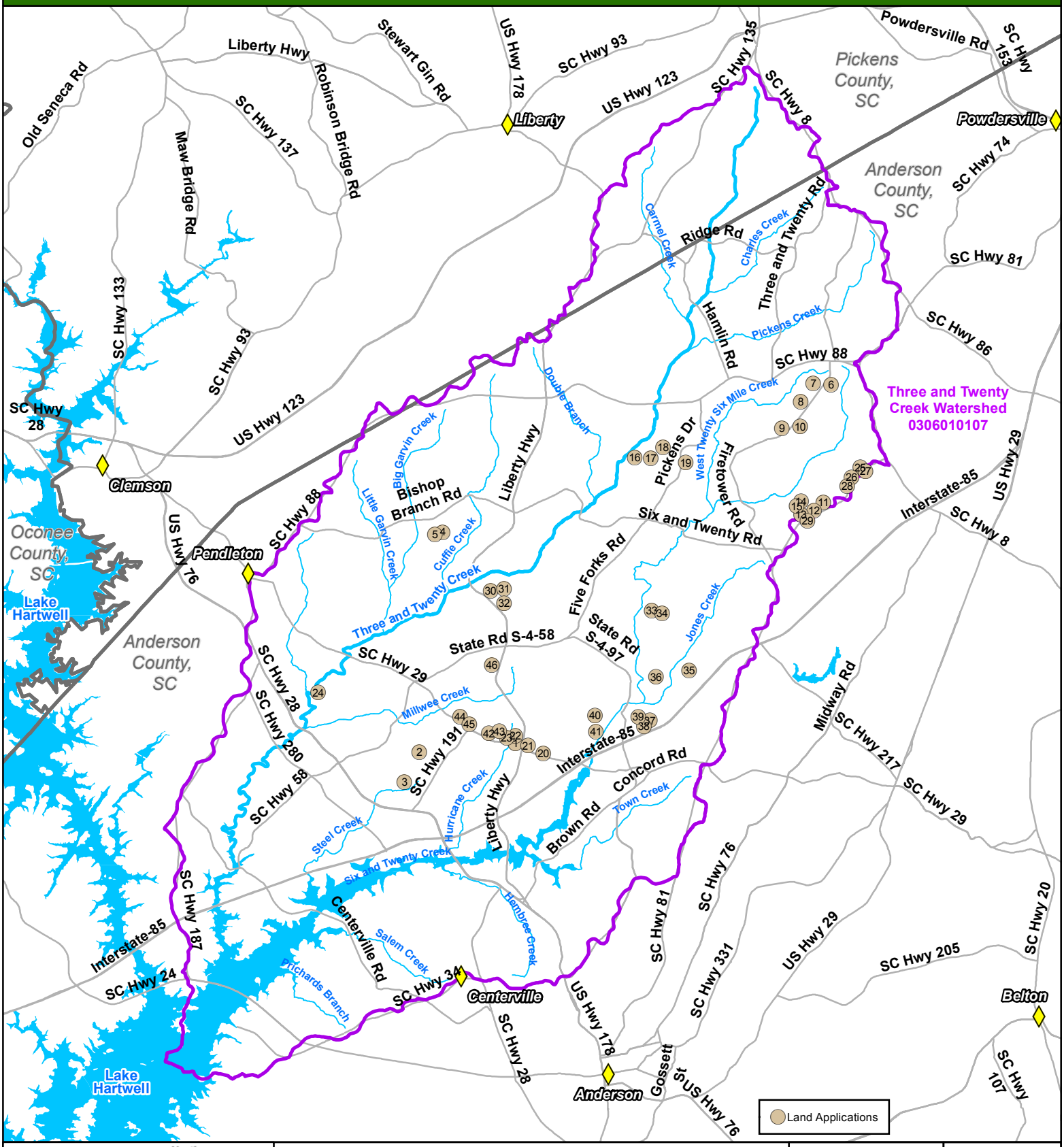
No-Discharge (ND) Class B Sludge Application Sites - There are 47 permitted No-Discharge Class B Sludge land application sites in the watershed (Table 13, Figure 8). These are sites where water treatment facilities are permitted to apply wastewater treatment effluent, non-hazardous sludge, and septage. These permits are considered No Discharge (ND) because there is no direct discharge to surface waters (SCDHEC, 2018). However, these sites have been included in this WBP as they have potential to contribute bacteria and nutrients to surface waters if managed improperly (e.g., if the applications take place during or preceeding rain events).

Table 13. No-Discharge Permits in Three and Twenty Creek Watershed

Map Id	Permit #	Generator	Facility Type
1	ND0000396	Walker Swine Slaughter Factory	Livestock Operation
2	ND0013684	Glenn Dairy Facility	Livestock Operation
3	ND0014184	Martin Dairy	Livestock Operation
4	ND0070955	Bishop Branch Farms Poultry	Livestock Operation
5	ND0070955	Bishop Branch Farms Poultry	Livestock Operation
6	ND0073253	Sludge-B Hanes Companies/Falcons Industries	Land Application
7	ND0073253	Sludge-B Hanes Companies/Falcons Industries	Land Application
8	ND0073253	Sludge-B Hanes Companies/Falcons Industries	Land Application
9	ND0073253	Sludge-B Hanes Companies/Falcons Industries	Land Application
10	ND0073253	Sludge-B Hanes Companies/Falcons Industries	Land Application
11	ND0073253	Sludge-B Hanes Companies/Falcons Industries	Land Application
12	ND0073253	Sludge-B Hanes Companies/Falcons Industries	Land Application
13	ND0073253	Sludge-B Hanes Companies/Falcons Industries	Land Application
14	ND0073253	Sludge-B Hanes Companies/Falcons Industries	Land Application
15	ND0073253	Sludge-B Hanes Companies/Falcons Industries	Land Application
16	ND0073253	Sludge-B Hanes Companies/Falcons Industries	Land Application
17	ND0073253	Sludge-B Hanes Companies/Falcons Industries	Land Application
18	ND0073253	Sludge-B Hanes Companies/Falcons Industries	Land Application
19	ND0073253	Sludge-B Hanes Companies/Falcons Industries	Land Application
20	ND0073253	Sludge-B Hanes Companies/Falcons Industries	Land Application
21	ND0073253	Sludge-B Hanes Companies/Falcons Industries	Land Application
22	ND0073253	Sludge-B Hanes Companies/Falcons Industries	Land Application
23	ND0073253	Sludge-B Hanes Companies/Falcons Industries	Land Application
24	ND0073253	Sludge-B Hanes Companies/Falcons Industries	Land Application
25	SC0048381	Sludge-B ReWa	Land Application
26	SC0048381	Sludge-B ReWa	Land Application
27	SC0048381	Sludge-B ReWa	Land Application
28	SC0048381	Sludge-B ReWa	Land Application
29	SC0048381	Sludge-B ReWa	Land Application
30	SC0048381	Sludge-B ReWa	Land Application
31	SC0048381	Sludge-B ReWa	Land Application
32	SC0048381	Sludge-B ReWa	Land Application

33	SC0048381	Sludge-B ReWa	Land Application
34	SC0048381	Sludge-B ReWa	Land Application
35	SC0048381	Sludge-B ReWa	Land Application
36	SC0048381	Sludge-B ReWa	Land Application
37	SC0048381	Sludge-B ReWa	Land Application
38	SC0048381	Sludge-B ReWa	Land Application
39	SC0048381	Sludge-B ReWa	Land Application
40	SC0048381	Sludge-B ReWa	Land Application
41	SC0048381	Sludge-B ReWa	Land Application
42	SC0048381	Sludge-B ReWa	Land Application
43	SC0048381	Sludge-B ReWa	Land Application
44	SC0048381	Sludge-B ReWa	Land Application
45	SC0048381	Sludge-B ReWa	Land Application
46	SC0048381	Sludge-B ReWa	Land Application
47	SC0047716	Sludge-B Pickens County	Land Application

Figure 8: No-Discharge Permits



Legend

- Cities/Towns
- Roads
- HUC-10: 0306010107 (Three and Twenty)
- County Line
- Lakes
- Streams
- Rivers/Creeks

0 0.75 1.5 3 4.5 6 Miles

N

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4.1.2) Nonpoint Sources of Bacteria Pollution

Nonpoint source pollution is caused by rainfall moving over and through the ground, transporting bacteria to waterways as it flows across the land surface. Nonpoint source bacteria pollution typically comes from septic systems, agriculture (e.g., livestock operations, cropland, and sediment), stormwater runoff, domestic pets, and wildlife. Approximately 60% of the land in the watershed is rural, so this plan emphasizes addressing bacterial inputs from agriculture, failing septic tanks, and domestic pets. Addressing wildlife populations directly can be difficult, therefore this plan will use public informational sessions to discourage spreading of nuisance wildlife populations in an effort to reduce their bacteria contributions.

Agriculture - Livestock are the primary agricultural concern for the increase of bacteria concentrations in waterways. Livestock with access to streams can contribute bacteria directly into waterways through their fecal matter or indirectly by disturbing streambanks and causing erosion. Runoff from agricultural facilities (e.g., farms feeding areas, manure storage areas) can also lead to increases in bacteria levels as well as other contaminants (e.g., fertilizers, pesticides, and sediment). Fertilizers such as manure and sludge, when applied to cultivated crops can also cause increased bacteria levels if applied in excess amounts or before rain events. Poultry operations are another concern in the region (NRCS, 2012). Poultry farms can pose a threat to water quality as they can generate significant amounts of chicken litter, dander, ammonia, and other wastes which can contaminate local waterways if not managed properly.

The number of animals in the watershed was estimated by combining information from the USDA Census of Agriculture with a GIS analysis of the acreage of farmland in the watershed. The acreage of farmland within the watershed is based on an analysis of the 2011 National Land Cover Database Land Cover within ArcGIS. The USDA Census of Agriculture provides the total acreage of farmland and total animal counts for each county; based on this, a ratio of animals per acre in Pickens and Anderson County was calculated. This ratio was then applied to the acreage of farmland within the watershed to estimate the total number of farm animals living within the boundaries of the watershed area. An example formula is shown below.

Formula 2: Calculating the Total Number of Animals in the Watershed

$$\text{Number of (Cattle) in the Watershed Area} = \left(\frac{\text{Total Number of (Cattle) within the County}}{\text{Total Acreage of Pasture Lands within the County}} \right) \times \text{Acreage of Farmland within Watershed Area}$$

Agricultural land, which for the purposes of this plan includes pasture/hay and cultivated crops, is found throughout the watershed and comprises approximately 28,343.83 acres. Livestock activity in the watershed was confirmed via aerial imagery and/or windshield surveys. Based on these calculations, approximately 4,324 cattle live in this watershed. Other farm animals that could impact surface water bacteria levels include horses, goats, sheep, swine, and poultry (Table 14). According to the 2015 South Carolina Permitted Poultry Facilities map (https://www.scdhec.gov/sites/default/files/docs/Environment/docs/poultry.pdf) there are over 15

poultry facilities located in Anderson County, and 1-2 poultry facilities inside the Three and Twenty Creek Watershed. As a result, the estimated number of poultry in the watershed is likely to be lower than the actual poultry population calculated for this watershed.

Table 14. Livestock Estimations in Three and Twenty Watershed

Livestock Type	Number of Livestock
Cattle	4,324
Swine	162
Sheep and Lamb	170
Horses	646
Poultry	295,887
Total	301,189

The total amount of bacteria loading from livestock was calculated using the annual pollutant load per land use. Stormwater runoff from pastureland, the primary land use associated with livestock, contributes bacteria to waterways in the region. For the purposes of this plan, pasture lands are considered those lands where livestock may graze (i.e., pasture/hay, grasslands land use categories). Using the median annual pollutant load rate of 1.60E+10 FC/year/hectare (see Appendix A), it was possible to estimate the total annual loading in the watershed for all livestock (Shaver et al., 2007). Bacteria loading from livestock in the Three and Twenty Watershed is approximately 1.82 E+14 bacteria/acre/year (Table 15). Annual pollutant loads based on acreage were obtained by multiplying the annual load by 0.404 (1 acre = 0.404 hectares) (Shaver et al., 2007).

Formula 3: Livestock Annual FC Loading

Livestock Annual FC Loading	=	(FC Median Load Rate (CFU/100 ml)	x	Pasture/ Grasslands (Acres))	x	Hectare to Acres Conversion Rate
1.82E+14	=	(1.60E+10	x	28,180.6)	x	0.404

Table 15. Annual FC Loading from Livestock in Three and Twenty Watershed

Pasture/ Grassland (Acres)	FC Median Load Rate (CFU/100 ml)	Livestock Annual FC Loading	Livestock Annual E.Coli Loading*
28,180.6	1.60E+10	1.82E+14	1.59E+14

*The numbers in this column were converted to *E.Coli* by multiplying the FC numbers by 0.8725

Croplands are another potential source of bacteria levels in waterways. Manure applications contain bacteria that may wash into nearby waterways during rain events. Severely eroded soils can contribute fertilizers, pesticides, sediments, and other toxins to the surface waters in the area. Based on overall acreage cropland, cultivated crops do not appear to be a major source of bacterial loading in the focus area, as there are roughly 163.2 acres of cropland in the entire region.

Septic Systems - Damaged or improperly maintained septic systems can be a significant nonpoint source of bacteria to surface and groundwater resources. Septic systems typically have four main components: an exit pipe that transports the wastewater out of the home to the septic tank, a septic tank where waste material naturally breaks down, a drain field where the effluent is discharged, and a soil layer that filters and breaks down wastewater contaminants. Improper connections, clogs, heavy use, or unmaintained systems increase the chance that untreated wastewater will leak into surface and groundwater resources.

A large portion of the approximately 16,825 homes in the focus area do not have access to sanitary sewer and rely on septic tanks to treat domestic wastewater. Based on information provided by local governments and utilities, there are approximately 1,730 customers served by sewer in the watershed. The sewer providers in the region include Anderson County Wastewater Department, Easley Combined Utilities (ECU), Electric City Utilities, Hammond Water and Sewer, and the Town of Pendleton. The limited sewer service available in the watershed is concentrated in the Electric City Utilities Water District, the southern portion of the Powdersville Water District, and along Highway 39 in the Sandy Springs Water District (Figure 9). It is estimated that an average of 20% of these septic systems are failing due to improper maintenance, age, or misuse (U.S EPA, 2002). For the purposes of the plan the anticipated number of failures in the focus area was determined by multiplying the estimated failure rate of 20% by total number of septic systems in the region. Using this information, there are approximately 3,019 failing septic systems in the watershed. Figure 9 shows the sewer service areas and lines within the watershed, giving an idea of those regions that should be targeted for septic repair programs.

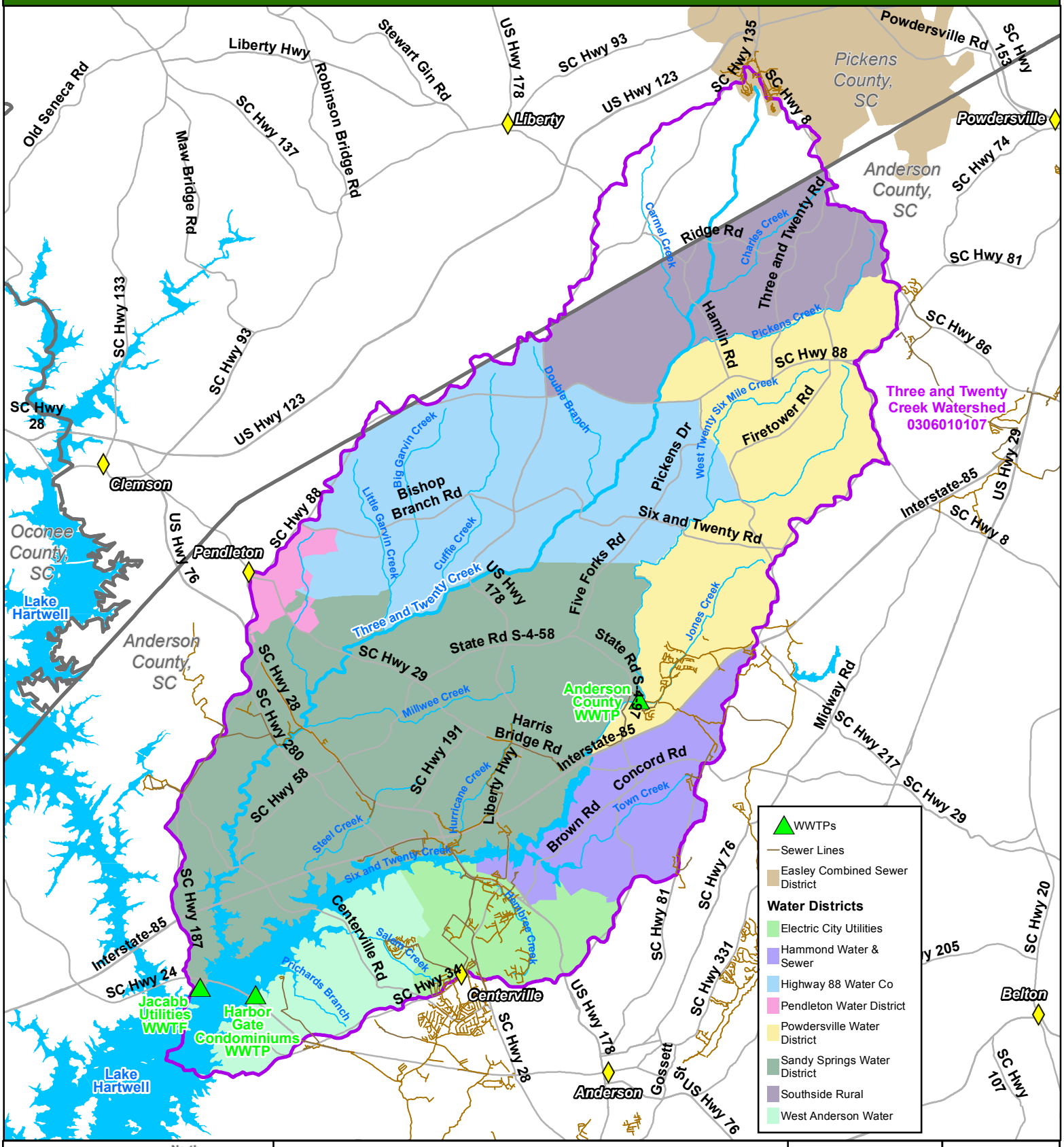
Formula 4: Estimated Number of Homes with Failing Septic Systems

# of Households with Failing Septic Systems	=	(Total # Households	-	# Households on Sewer)	x	Mean Septic Failure Rate
3,019	=	(16,825	-	1,730)	x	0.20

Table 16. Estimated Number of Septic Systems in Three and Twenty Watershed

# Households	# Households on Sewer	# Households with Onsite Septic Systems	# Households with Failing Septic Systems
16,825	1,730	15,095	3,019

Figure 9: Wastewater Services



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Domestic Pets - Domestic pet waste is a threat to human health and water quality when not disposed of properly. Pet waste left on the ground can be carried by stormwater into nearby waterways and is a concern in developed areas containing higher densities of impervious surfaces. Developed land accounts for roughly 21% of total land cover in the focus area and is concentrated along the major transportation corridors (i.e., Interstate 85, US Highway 78, US Highway 178, SC Highway 88, and the communities of Centerville and Pendleton). In general, most of the development in the developed land category is considered medium to low density, with a few small pockets of high density development in the southern portion of the watershed (Figure 4).

According to the U.S EPA, a single dog can produce approximately 276 pounds of waste each year. Pet waste can contain harmful organisms such as bacteria, viruses, and parasites. Using the total number of households within a watershed area (as calculated in Section 2 using data from the U.S. Census) and a formula prepared by the American Veterinary Medical Foundation shown below, it was determined that roughly 9,426 dogs live within the planning area.

Formula 5: Estimated Number of Dog-Owning Households

Number of Dog Owning Households	=	National Percentage of Dog Owning Homes*	x	Total Number of Households
6,326 Homes with Dogs	=	0.376	x	16,825 Homes

**This number comes from the Humane Society of the US's 2017-2018 American Pet Products Association Survey and is the average of dog-owning households with small, medium, and large dogs*

Formula 6: Estimated Number of Dogs within the Watershed

Number of Dogs	=	National Average of Dogs in Homes*	x	Total Number of Dog-Owning Households
9,426	=	1.49	x	6,326 Dog-Owning Households

**This number comes from the Humane Society of the US's 2017-2018 American Pet Products Association Survey*

Based on the calculated number of dogs within the watershed and the U.S EPA dog waste statistic (dog can produce 276 lbs/year), dogs living within the watershed produce approximately 2.6 million pounds of waste annually (Greenville County Soil and Water, 2018).

Public outreach campaigns on proper pet waste disposal will be necessary to reduce bacterial loading in the watershed. For this reason, the location and number of pet stores, feed and seed

stores, animal shelters, and pet groomers have been identified in the watershed. Such businesses and organizations may prove helpful in sharing information on the environmental and human health risks of pet waste in waterways. In addition, community parks have been identified as places where pet waste stations would be effective. Both pet stores and community parks will be effective in the distribution of pet waste information as well as pet waste station installations. For a full list of pet stores, animal hospitals and community parks, please see Appendix A.

Wildlife - Wildlife have the potential of impacting the bacteria levels in water and do appear to be a contributor to elevated levels of bacteria in this watershed. However, bacterial impacts from wildlife on forested lands are often reduced due to the undisturbed state of the soils and vegetation. Because forested land accounts for over 46% of land cover in the focus area, it is assumed that wildlife in these areas do not have a major effect on bacteria levels in the watershed. Forested land density is dispersed across the watershed. The predominant forest type across the focus area is deciduous, accounting for 76% of the forest cover. Evergreen forests make up 23% of the forest cover, and mixed forest accounts for less than 1% of total forest acreage.

Within the planning area, nuisance wildlife populations are increasing. Examples of nuisance species include deer, geese, beavers, and feral hogs. A single Canadian goose can produce an average of 82 grams (2.6 ounces) of waste a day (Lake Access, 2017) thereby leading to water quality problems in areas with high populations. Feral hogs, present in the focus area, are a threat to water quality because their rooting behavior contributes to soil erosion while their fecal matter contains viruses and pathogens which can be transmitted to human populations (SCDNR, 2017; Miller, 2016).

5) BACTERIA LOAD REDUCTIONS

The bacteria load reductions included in this plan were based on the *TMDLs for Fecal Coliform for Eighteen Mile Creek, Three and Twenty Creek, Little River and Long Cane Creek Watersheds in the Savannah River Basin, South Carolina* (SCDHEC, 2005). The purpose of a TMDL is to reduce pollutant loading into a stream; with the goal of restoring the stream's water quality and U.S EPA designated use. A TMDL is expressed as "the sum of all Waste Load Allocations (WLAs: point source loads), Load Allocations (LAs: nonpoint source loads and background), and a Margin of Safety (MOS), which accounts for uncertainty concerning the relationship between effluent limitations and water quality" (U.S EPA, 2007). A summary of the bacteria load reductions within the Three and Twenty Creek can be found in Table 17. FC values have been converted to *E. coli* values by multiplying by 0.8725 (SCDHEC, 2013). The TMDLs are calculated using the following equation:

Formula 7: TMDL Calculation

$$TMDL = \sum WLA + \sum LA + MOS$$

Table 17: TMDL Summary of Bacteria Reductions within Three and Twenty Creek

WQMS	WLAs (counts/day)	MS4 WLA (% Reduction)	Existing Nonpoint LA (counts/day of % reduction)	MOS (Margin of Safety)	TMDL (counts/day or % reduction)	Percent Reduction	Bacteria
SV-111	6.44E+09	NA	9.60E+11	5.08E+10	1.02E+12	55	Fecal Coliform
SV-111	5.62E+09	NA	8.38E+11	4.43E+10	8.90E+11	55	E.Coli*

*The numbers in this row were converted to E.Coli by multiplying the FC numbers by 0.8725

5.1) Bacteria Load Reduction Calculations

Bacteria load reductions for this plan were based on 2005 TMDLs, *TMDLs for Fecal Coliform for Eighteen Mile Creek, Three and Twenty Creek, Little River and Long Cane Creek Watersheds in the Savannah River Basin, South Carolina* (SCDHEC, 2005). The TMDLs include both point and nonpoint sources in the bacteria load calculations. This information was used to calculate specific nonpoint source bacteria load reductions for the focus area.

Waste Load Allocation (WLA) - This information comes directly from the 2005 TMDL (Table 5-5, page 5-9) (SCDHEC, 2005) and represents bacteria from point sources. The Waste Load Allocation (WLA) at SV-111 is 6.44E+09 counts/day (SCDHEC, 2005).

MS4 WLA (% Reduction) – This method for estimating the percent reduction of fecal coliform loading within an MS4 area is represented in percentage since WLAs for each MS4 cannot be calculated as an individual value.

Existing Nonpoint Load (LA) - Existing Nonpoint Load represents the bacteria load from nonpoint sources and is calculated, as shown below. Subtracting WLA and MOS from the TMDL Existing Load helps in calculating the nonpoint load reduction (counts/day).

Formula 8: Calculating Existing Nonpoint Load Allocations

Existing Nonpoint LA	=	TMDL	-	WLA	-	MOS	
9.60E+11	=	1.02E+12	-	6.44E+09	-	5.08E+10	*Fecal Coliform*
8.38E+11	=	8.90E+11	-	5.62E+09	-	4.43E+10	*E. Coli*

Margin of Safety (MOS) – A TMDL consists of WLA, LA, and a MOS. The MOS is a percentage of the TMDL that accounts for the uncertainty associated with the TMDL model's assumptions and data limitations (SCDHEC, 2005).

TMDL – The TMDL consists of the WLA (point source load), LA (nonpoint source load), and the MOS (see equation above in Section 5) in counts/day.

TMDL Existing Load – This calculation comes directly from the 2005 TMDL (Table 5-3, page 5-5) and represents the total bacteria load from both point and nonpoint sources including continuous point source dischargers, MS4s, Sanitary Sewer Overflows, failing septic systems, wildlife, domestic pets, and livestock. The TMDL Estimated Existing Loading at SV-111 is 2.13E+12 counts/day (SCDHEC, 2005). This number is not represented in Table 17.

Nonpoint Load Reduction Needed was calculated using information from this document and represents the bacteria reduction needed from nonpoint sources per day and year in the watershed in order to meet water quality standards.

Formula 9: Calculating Daily Nonpoint Load Reductions Needed

Nonpoint Load Redcution Needed (counts/day)	=	Existing Nonpoint LA (counts/day)	x	TMDL Nonpoint Percent Reduction Needed	
5.28E+11	=	9.60E+11	x	55%	*Fecal Coliform*
4.61E+11	=	8.38E+11	x	55%	*E. Coli*

Nonpoint Load Reduction Needed (counts/year) - This represents the bacteria load reduction needed from nonpoint sources and is calculated by multiplying the Existing Nonpoint Load Allocation by the TMDL Nonpoint Percent Reduction Needed by 365 days/year. Results are shown in counts/year, to facilitate calculations for recommended BMP installations per year.

Formula 10: Calculating Annual Nonpoint Load Reductions Needed

Nonpoint Load Reduction Needed (counts/year)	=	Nonpoint Load Reduction Needed (counts/day)	x	365 days/year	
1.92E+14	=	5.28E+11	x	365 days/year	*Fecal Coliform*
1.67E+14	=	4.61E+11	x	365 days/year	*E.Coli*

Table 18 summarizes the nonpoint load reductions needed in the Three and Twenty Creek based on information for SV-111 in the 2005 TMDL. This information was derived from Table 17 above and is used to calculate the BMP load reductions included in this plan. Because the current water quality standards are listed as *E.Coli*, estimated load reductions needed and BMP load reductions included in this plan are listed in *E.Coli* values.

Table 18. Estimating *E. Coli* Load Reductions Needed

***E. coli* Load Reductions**	**Three and Twenty Creek**
Counts/day	4.61E+11
Counts/year	1.68E+14

5.2) Bacterial Loading and Reductions by BMP

Bacterial loading and reductions were estimated for the three BMP categories: septic, agricultural, and pet waste. These recommendations were calculated based on the estimated actual number of failing septic systems, pasture land within 0.25 miles of streams, and approximate number of pets in the watershed.

5.2.1) Septic Loading and Reductions

Total possible septic reductions respresents the amount of bacteria that could be removed annually by targeting potentially failing septic systems for repair or replacement. This information was derived using the standard annual contribution of bacteria per septic system and the estimated number of failing septic systems. For example, there are an estimated 3,019 failing septic systems in the Three and Twenty Creek Watershed. Bacteria loads from these failing septic systems would contribute roughly 2.42E+10 bacteria/year to waterways in the Three and Twenty Creek Watershed.

Formula 11: Estimated Total Possible Septic Bacteria Reductions in the Watershed

Total Possible Reductions for Septic in Watershed	=	Estimated # of Homes on Septic in Watershed	x	Estimated Septic Failure Rate	x	Standard Contribution of Bacteria per Septic per Year
7.31E+13	=	15,095	x	20%	x	2.42E+10

5.2.2) Agricultural Loading and Reductions

Total possible agricultural reductions respresents the amount of bacteria that could be removed annually by targeting livestock within a 0.25 mile of waterways by fencing livestock out of streams and/or improving riparian buffers. This information was derived using the standard *E.Coli* loading rate from pasture lands and the number of acres of pasture lands within 0.25 miles of waterways. For example, there 27,998 acres of pasture lands within 0.25 miles of rivers in the Three and Twenty Creek Watershed. Runoff from these pasture lands would contribute roughly 4.48E+14 bacteria/year to local waterways.

Formula 12: Estimated Total Possible Agricultural Bacteria Reductions in the Watershed

Total Possible Reductions for Agriculture in Watershed	=	Acres of Pasture within 0.25 miles of Waterways in Watershed	x	Estimated Bacteria Loading per Acre of Pasture	x	Bacteria/Acre-Year Conversion
1.81E+14	=	27,998	x	1.60E+10	x	0.404

5.2.3) Pet Waste Loading and Reductions

Total possible pet waste reductions represent the annual bacteria reductions expected from the installation of pet waste stations in the watershed, with an assumed 50% success rate. The standard annual *E.Coli* bacteria load per dog is 1.49E+12 bacteria a year. The recommended pet waste

reduction was calculated by multiplying the number of dogs in the area (9,426) by the 50% success rate and the annual standard bacteria load per dog.

Formula 13: Estimated Total Possible Pet Waste Bacteria Reductions in the Watershed

Total Possible Reductions for Pet Waste	=	Number of Pets in Watershed	x	Success Rate	x	Standard Bacteria Loading Per Dog/Year
7.02E+15	=	9,426	x	50%	x	1.49E+12

5.2.4) Total Recommended Bacteria Redcuctions and BMPs

To reach the total possible annual bacteria reductions of 7.26E+15 for septic, agricultural, and pet waste BMPs, a large number of projects would have to be completed. For example, it would take the repair or replacement of all 3,019 estimated failing septic systems in the watershed to achieve the total possible reductions for septic. Table 19 summarizes the calculations in Sections 5.2.1 – 5.2.3 and how many projects it would take to meet the total possible annual bacteria load reductions. The standard bacteria equivalents used to estimate the loads for all sources are found in Appendix C and D. These standards are as follows: septic systems – 2.42E+10 bacteria/year; agricultural BMPs – 1.62E+13 bacteria/year, and a single pet waste station – 2.19E+12 bacteria/year.

Table 19. Total Possible Annual Bacteria Reductions

BMP	Standard Bacteria Removal per BMP	# of Projects	Total Possible Annual Bacteria Reductions
Septic Repair/Replacement	2.42E+10	3,019	7.31E+13
Agricultural BMPs bundle	1.62E+13	12	1.94E+14
Pet Waste Station	2.19E+12	3,206	7.02E+15
Total			**7.27E+15**

As mentioned in Table 18, the total annual bacteria load reductions needed to satisfy the TMDL is 1.68E+14 counts/year. Table 20 outlines the approximate number of BMPs recommended to achieve the needed annual bacteria reductions per the TMDL, and provide significant water quality improvements. These estimations were derived using the standard annual bacteria removal rates for each BMP multiplied by the suggested number of BMPs in the watershed.

Table 20. Total Annual Recommended Bacteria Reductions and BMPs

BMP	Standard Bacteria Removal per BMP	# of Projects	Total Bacteria Reduction Per BMP
Septic Repair/Replacement	2.42E+10	60	1.45E+12
Agricultural BMPs bundle	1.62E+13	12	1.94E+14
Pet Waste Station	2.19E+12	5	1.10E+13
Total			**2.07E+14**

6) SEDIMENT LOAD REDUCTIONS

6.1) Sediment Pollution

According to the U.S EPA, sediment is the most common pollutant in rivers, streams, lakes, and reservoirs in the country (Shelton, 2005). Sediment can come from both natural sources (e.g., erosion) and human induced activities (e.g., construction and agriculture). Excess sediment has the potential to degrade water quality and aquatic habitats. For example, too much sediment can increase the cost of drinking water treatment, lead to flooding issues, clog fish gills, and destroy aquatic habitats. Although approximately 30% of sedimentation can be attributed to natural erosion, the remaining 70% is caused by accelerated erosion from human land use practices (Shelton, 2005).

Annual sediment loading for the watershed was calculated using the Spreadsheet Tool for Estimating Pollutant Load (STEPL). The STEPL model estimates annual sediment and nutrient loading based on the Universal Soil Loss Equation (USLE) and considers sediment loading from land uses (e.g., urban, cropland, pastureland, and forest lands) (U.S EPA, 2018). Using this tool, it is estimated that cumulatively, the watershed contributes 11,032 tons of sediment per year to the region, largely attributed to pasturelands and urban development. The breakdown of annual sediment loading per land use is shown in Figure 10.

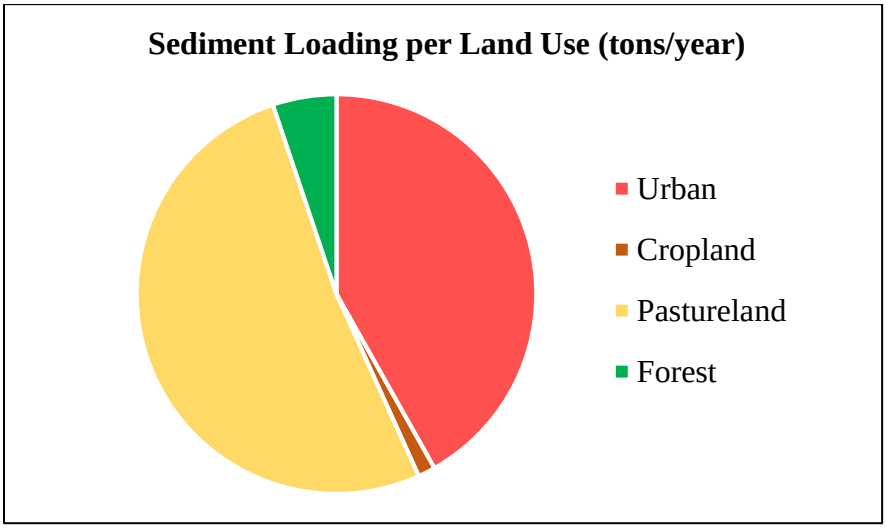

Figure 10. Annual Sediment Loading per Land Use Category for Three and Twenty Creek

6.1.1) Point Sources of Sediment Pollution

As stated in Section 6.1 above, the NPDES permit system, operated by SCDHEC in South Carolina, protects water quality by regulating point sources of pollution from being discharged into Waters of the United States (U.S EPA, 2018). Sediment is regulated from stormwater point sources within the Municipal Separate Storm Sewer System (MS4) program area, stormwater from construction sites, and stormwater associated with industrial permits (SCDHEC, 2018). Portions of the watershed fall under Phase 2 (Small) MS4 designations for Anderson and Pickens Counties (SCDHEC SC Watershed Atlas, 2018). See Table 13 for a complete list of NPDES permits in the watershed.

6.1.2) Nonpoint Sources of Sediment Pollution

The excess sedimentation of freshwaters from nonpoint source pollution is a prevalent problem in the focus area. Nonpoint sources of sediment pollution typically include construction sites, agriculture (e.g., livestock operations, cropland), stormwater runoff, and forestry practices. Sediment is considered a nonpoint source pollutant both inside and outside of MS4 boundaries (Table 21). In fact, sediment has been identified as one of the top five pollutants of concern in the region by the Anderson Pickens County Stormwater Partners, a group of Small Municipal Separate Storm Sewer Systems (SMS4s) community partners dedicated to the regional stormwater education concept (Clemson University, 2018).

Table 21. Sources of Sediment Pollution in Watershed

Agriculture	Urban	Forestry
• Croplands • Livestock Operations	• Stormwater Runoff • Construction	• Road Construction • Road Use • Clear Cutting

Agriculture - The most common source of pollution from agriculture is soil that is washed from fields during rain events (U.S EPA, 2005). This sediment often transports contaminants including fertilizers, pesticides, and heavy metals into waterways. Agricultural practices that exacerbate sediment erosion include overgrazing, misplaced and mismanaged feeding operations, over plowing, and poorly timed or excessive fertilizer, pesticide, and irrigation water applications. Additionally, livestock with access to streams can also contribute to sediment pollution by causing erosion along streambanks.

Urban - The urbanization of watersheds often has negative impacts on water quality. Activities most associated with urbanization are land disturbances, channelization of streams, the expansion of impervious surfaces, and increases in the stormwater runoff (SC AAS, 2018). Sediment pollution from urban areas is usually linked to mismanaged construction sites but can also come from streets, yards, and the stream itself. In both Anderson and Pickens Counties all activities disturbing one or more acres of land, or smaller sites (< 1 acre) within a larger common plan, are permitted and inspected by the respective County to ensure compliance with their Stormwater Ordinance (Anderson County Stormwater Ordinance, 2007, Pickens County Stormwater Ordinance, 2007).

Forestry - Sediment pollution associated with forestry practices is most often attributed to the construction and use of logging roads. However, the removal of trees and vegetation along streambanks, and mechanical tree planting activities can contribute to increases in sediment loading to waterways (U.S EPA, 2018). This is a concern because there is a high potential for growth in the residential, commercial development in Anderson County, with approximately 155,651 acres of land predicted to be consumed in the next 25 years (CityExplained, 2017; Urban 3, 2017). As a result, runoff volume and annual suspended sediment loads are projected to increase in the watershed.

6.2) Sediment Load Reductions Per BMP

Sediment load reductions were estimated for three BMP categories: protected lands, agricultural lands, and riparian buffers. Each of these load reductions were based upon the high priority sites from the respective categories (See Sections 10, 12, and 14). Load reductions for agricultural and riparian buffer BMPs were calculated using the STEPL model (see Appendix E). Land protection sediment reductions were derived based on standard land use annual pollutant loadings per unit area (Shaver et al., 2007).

6.2.1) Agricultural BMP Sediment Reductions

Agricultural sediment load reductions respresent the amount of sediment projected to be removed annually through the use of agricultural BMPs installed on high priority agricultural sites within the watershed. In this plan the typical agricultural BMP package includes exclusion fencing, heavy use areas, alternate water sources, and riparian buffer improvements (e.g., grass, vegetation, other erosion control techniques). The combined sediment removal for a single agricultural BMP package was estimated using STEPL for a 1-acre parcel assuming exclusion fencing, alternate water source, heavy use area, and a basic grassed buffer and equaled 0.002 tons sediment/year. Total sediment reductions for the watershed using agricultural BMPs was calculated by multiplying the total removal per agricultural package by the number of high priority parcels for the watershed (Formula 14). There are 676 high priority agricultural properties in the Three and Twenty Watershed. Installing the recommended BMPs on these sites would reduce sediment loading by 1.352 tons/year or 2,704 lbs/year.

Typical Agricultural BMP Package	=	▪ Livestock Exclusion Fencing ▪ Alternative Water Source ▪ Heavy Use Area ▪ 35 m Improved Buffer

Formula 14: Estimated Total Possible Agricultural Sediment Removal in the Watershed

Estimated Total Possible Sediment Removal in Watershed	=	Sediment Removal Per Typical Agricultural BMP Package	x	Number of High Priority Agricultural Sites in Watershed
2,704 tons/year	=	4 tons/year	x	676

6.2.2) Land Protection Sediment Reductions

Sediment reductions from Land Protection represent the amount of sediment that is prevented from impacting waterways if significant development of the land is avoided. This number was derived using the estimated Annual Pollutant Loads by Land Use for Total Suspended Solids (TSS) for the conversion of undeveloped land into single family low density residential (Shaver et al., 2007). In this calculation Current Land Use is represented as a combination of TSS loading from agricutural pasture lands and forest lands within the High Priority Land Protection parcels. Refer to the calculation below for the total estimated sediment removal rates using land protection BMPs.

Formula 15: Estimated Total Possible Land Protection Sediment Removal in the Watershed

Estimated TSS Removal From Land Protection	=	TSS Load per Single Family Low Residential Land Use	-	TSS Load per Current Land Use (TSS Agricultural + TSS Forest)
204.7 tons/acre/year	=	1,134.9 tons/acre/year	-	(722.1 + 208.1) tons/acre/year

6.2.3) Riparian Buffer Restoration Sediment Reductions

Sediment removal estimates for riparian buffers represent the amount of sediment that is prevented from impacting waterways if riparian buffers are protected, enhanced, and/or restored. Examples of actions include, but are not limited to: riparian buffer protection ordinances, planting vegetation, implementing a variety of erosion control techniques, and stream enhancement/restoration activities. These removal estimates were determined using STEPL. For this analysis, the high priority riparian buffer sites on non-agricultural lands within the watershed were determined in GIS by selecting all high priority riparian sites and then removing all properties that included agricultural lands to ensure that these parcels were not double counted for agricultural and riparian buffer sediment reductions. See Appendix G for more information on STEPL calculations for sediment removal using riparian buffers.

Formula 16: Estimated Total Possible Riparian Buffer Sediment Removal in the Watershed

Estimated Total Possible Sediment Removal in Watershed	=	Sediment Removal Per Typical Riparian Buffer Restoration Project	x	Number of Non-Ag High Priority Riparian Buffer Restoration Sites in the Watershed
14,768 lbs/year	=	52 lbs/year	x	284

6.2.4) Total Recommended Sediment Reductions and BMPs

To reach the total possible annual sediment reductions of 2,613,521.584 tons/year for agricultural, land protection, and riparian buffer restoration BMPs, a very large number of projects would have to be completed. For example, it would take the installation of an agricultural BMP bundle on all 676 identified high priority sites for agricultural BMPs (see Section 12) to meet the total possible annual sediment reductions of 2,704 tons. Additionally, based on the total acreage of identified high priority parcels (see Section 12), nearly 12,800 acres would need to be protected to meet the total possible annual sediment reductions for land protection. Table 22 summarizes the calculations in sections 6.2.1 – 6.2.3 and the number of projects required to meet the total possible annual sediment load reductions.

Table 22. Total Possible Annual Sediment Reductions

BMP	Standard Sediment Removal per BMP	# of Projects	Total Possible Annual Sediment Reductions (tons/year)	Total Possible Annual Sediment Reductions (lbs/year)
Agricultural BMPs bundle	4 tons/year	676	2,704 tons/year	5,408,000 lbs/year*
Land Protection	204.7 tons/acre/year	12,768.98 acres	2,613,810.2 tons/year	5,227,620,412 lbs/year*
Riparian Buffer Restoration	52 lbs/year	284	7.384 tons/year**	14,768 lbs/year
Total			**2,616,521.584 tons/year**	**5,233,043,180 lbs/year**

* The numbers in these cells were converted from tons to pounds by multiplying Totals by 2000
**The numbers in these cells were converted from pounds to tons by multiplying Totals by 0.005

As mentioned in Section 6.1, the watershed contributes 11,032 tons of sediment per year to the region with the majority of the loading attributed to pasturelands and urban development. Table 23 outlines the approximate number of BMPs recommended to achieve a reduction of this amount. These estimations were derived using the standard annual sediment removal rates for each BMP multiplied by the suggested number of BMPs in the watershed to attain the necessary reductions. The number of Agricultural BMPs was taken from the recommended number of projects to meet bacteria load reductions (Section 5.2).

Table 23. Total Annual Recommended Sediment Reductions and BMPs

BMP	Standard Sediment Removal per BMP	# of Projects	Total Sediment Reduction Per BMP
Agricultural BMPs bundle	4 tons/year	12	48 tons/year
Land Protection	204.7 tons/acre/year	55 acres	11,258.5 tons/year
Riparian Buffer Restoration	52 lbs/year (0.026 tons/year)	5	0.13 tons/year
Total			**11,306.63 tons/year**

7) NUTRIENT LOAD REDUCTIONS

7.1) Nutrient Pollution

Nutrient pollution is considered one of the most widespread and difficult challenges for water quality in the U.S. (U.S EPA, 2018). Excess levels of nitrogen and phosphorus can cause algal blooms in surface waters and increased nitrate concentrations in groundwater systems (Hoosier Environmental Council, 2018). Nutrient pollution is associated with both point and nonpoint sources, and is mostly attributed to human activities (Table 24).

Annual nutrient loading for the watershed was calculated using the Spreadsheet Tool for Estimating Pollutant Load (STEPL). The STEPL model estimates annual sediment and nutrient

loading based on the Universal Soil Loss Equation (USLE) and considers nutrient loading from land uses (e.g., urban, cropland, pastureland, and forest lands) (U.S EPA, 2018). Using this tool, it is estimated that cumulatively, the watershed contributes 97,326.8 pounds of phosphorus per year and 537,787.4 pounds of nitrogen to the region with the majority of the loading attributed to pasturelands and urban development. The breakdown of annual nutrient loading per land use is shown in Figure 11.

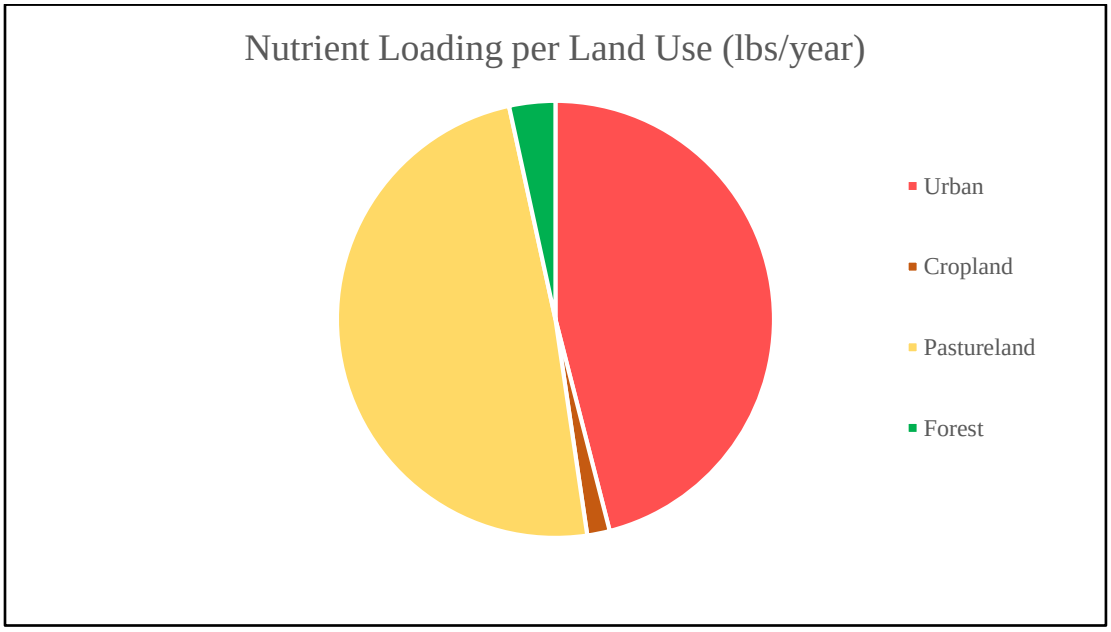

Figure 11. Annual Nutrient Loading per Land Use Category for Three and Twenty Creek

7.1.1) Point Sources of Nutrients

The primary point sources of nutrients include sewage treatment plants, industry, and factories. As stated in Section 4.1.1 the NPDES system controls water pollution by regulating point sources that discharge pollutants into Waters of the United States.

Table 24. Sources of Nutrient Pollution in Focus Area

Agriculture	Urban	Wastewater	Industrial
• Livestock • Fertilizer applications • Soil erosion	• Stormwater Runoff • Yard Waste • Yard Fertilizers • Pet waste	• WWTPs • Septic Systems	• Factories

NPDES Discharges – There are five NPDES facilities permitted to discharge nutrients into surface waters in the Three and Twenty Creek Watershed (Figure 7). These facilities are regulated by SCDHEC to ensure compliance with the Clean Water Act.

ND Sludge Applications – There are 47 permitted No-Discharge Class B Sludge land application sites in the watershed (Table 13, Figure 8). These are sites where water treatment facilities are permitted to apply wastewater treatment effluent, non-hazardous sludge, and septage.

7.1.2) Nonpoint Sources of Nutrients

Nutrient pollution from nonpoint sources is common in the Three and Twenty Creek Watershed. Excess nitrogen and phosphorus washes into local waterways from agricultural and urban sources as well as from domestic wastewater. Annual nutrient loading for the watershed was calculated using the STEPL model. According to STEPL, it is estimated that cumulatively land uses in the Three and Twenty Creek Watershed contribute approximately 537,787 pounds (lbs) and 97,327 lbs of nitrogen and phosphorus, respectively per year. The distribution of annual nitrogen and phosphorus loading per land use is shown in Figure 12.

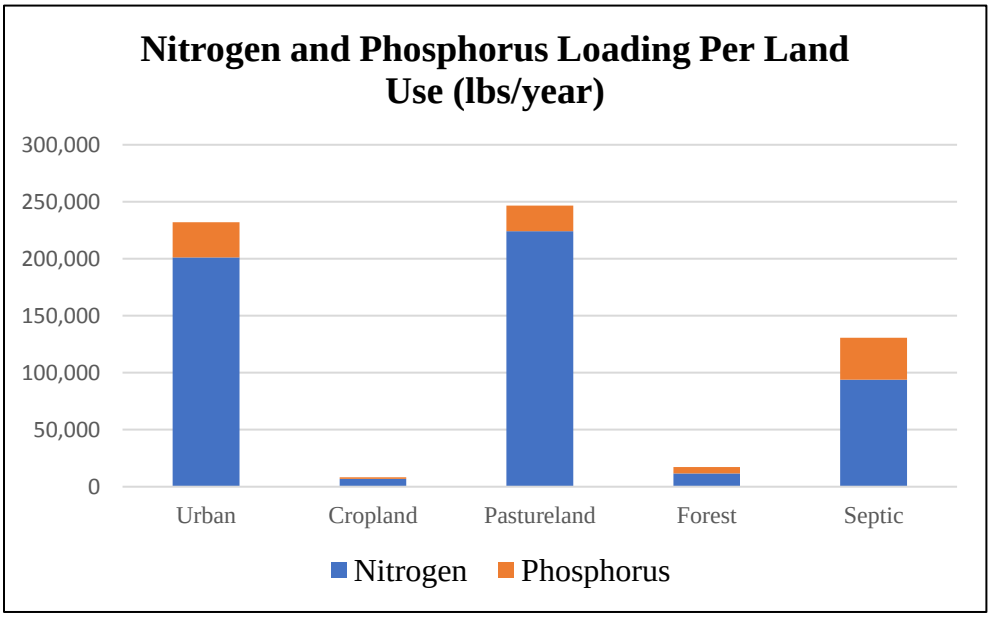

Figure 12. Nutrient Loading per land use category in Three and Twenty Watershed.

Agriculture - Agriculture is considered one of the largest sources of nitrogen and phosphorus pollution to waterways in the country (U.S. EPA, 2018). Fertilizers and animal manure, both rich with nitrogen and phosphorus, are the primary causes of nutrient pollution from agriculture when not managed properly. Restricting livestock access to streams and properly managing fertilizer applications protects water quality by reducing the amount of excess nutrients from washing into local waterways.

Urban - Nutrient pollution from urban areas is typically attributed to stormwater runoff. As impervious surfaces in a region increase (e.g., roads, parking lots, roof tops) landscapes lose their ability to absorb precipitation during rain events. As a result, stormwater washes off these surfaces at higher volumes and speeds, picking up pollutants in the process, and then discharging into local rivers and streams. Nitrogen and phosphorous can be found in yard waste, fertilizers, and pet waste.

Wastewater - Domestic wastewater contains nutrients (i.e., nitrogen and phosphorus) from human waste, food scraps, as well as certain soaps and detergents. Consequently, improperly managed septic systems are a potential source of nutrient pollution in the Three and Twenty Creek Watershed. When improperly managed, septic systems can release nitrogen and phosphorus into local waterways or groundwater (U.S.EPA, 2018).

7.2) Nutrient Load Reductions Per BMP

Nutirent load reductions were also estimated for the three recommended BMP categories: protected lands, agricultural lands, and riparian buffers. As with sediment each of these load reductions were based upon the high priority sites from the respective categories (See Sections 10, 12, and 14) and were calculated using the STEPL mode (U.S. EPA, 2019). Land protection nutrient reductions for Total Nitrogen (TN) and Total Phosphorus (TP) were derived based on standard median land use annual pollutant loadings per unit area for Single Family Low Density, Pasture, and Forest (Shaver et al., 2007).

7.2.1) Agricultural Nutrient Load Reductions

Agricultural TN and TP load reductions reflect the amount of nutrients projected to be removed annually through the use of agricultural BMPs installed on high priority agricultural sites within the Three and Twenty Watershed. Agricultural BMP reductions were based on a typical agricultural BMP package (i.e., use of exclusion fencing, alternate water sources, heavy use areas, and a basic grass buffer) (see Section 6.1). Reductions were estimated using STEPL for a 1 acre parcel, equaling 0.002 tons sediment/year. Total sediment reductions for the watershed using agricultural BMPs were calculated by multiplying the total removal per agricultural package by the number of high priority parcels for the watershed. There are 676 high priority agricultural properties in the Three and Twenty Watershed. Installing the recommended BMPs on these sites would reduce nutrient loading by 8.788 tons/year or 17,576 lbs/year.

Typical Agricultural BMP Package	=	▪ Livestock Exclusion Fencing ▪ Alternative Water Source ▪ Heavy Use Area ▪ 35 m Improved Buffer

Formula 17: Estimated Total Possible Agricultural Phosphorus Reductions in the Watershed

Estimated Total TP Removal in Watershed	=	TP Removal Per Typical Agricultural BMP Package	x	Number of High Priority Agricultural Sites in Watershed
3,380 lbs/year	=	5 lbs/year	x	676

Formula 18: Estimated Total Possible Agricultural Nitrogen Reductions in the Watershed

Estimated Total TN Removal in Watershed	=	TN Removal Per Typical Agricultural BMP Package	x	Number of High Priority Agricultural Sites in Watershed
14,196 lbs/year	=	21 lbs/year	x	676

7.2.2) Land Protection Nutrient Load Reductions

Nutrient reductions (i.e., TP, TN) from land protection represent the amount of sediment that is prevented from impacting waterways if significant development of the land is avoided. This number was derived using the estimated annual pollutant loads by land use for TP and TN for the conversion of undeveloped land into single family low density residential (Shaver, et al, 2007). In this calculation, current land use is represented as a combination of TP and TN loading from agricutural pasture lands and forest lands within the high priority land protection parcels. Refer to the calculation below for the total estimated nutrient removal rates using land protection BMPs.

Formula 19: Estimated Total Possible Land Protection Phosphorus Reductions in the Watershed

Estimated TP Removal From Land Protection	=	TP Load per Single Family Low Residential Land Use	-	TP Load per Current Land Use (TP Agricultural + TP Forest)
2.6 tons/acre/year	=	3.1 tons/acre/year	-	(0.3 + 0.3) tons/acre/year

Formula 20: Estimated Total Possible Land Protection Nitrogen Reductions in the Watershed

Estimated TN Removal From Land Protection	=	TN Load per Single Family Low Residential Land Use	-	TN Load per Current Land Use (TN Agricultural + TN Forest)
9.0 tons/acre/year	=	22.7 tons/acre/year	-	(8.8 + 4.8) tons/acre/year

7.2.3) Riparian Buffer Restoration Nutrient Load Reductions

Nutrient removal estimates for riparian buffers represent nutrient loading prevented from impacting waterways if riparian buffers are protected, enhanced, and/or restored. Examples of actions include, but are not limited to: riparian buffer protection ordinances, planting vegetation, implementing a variety of erosion control techniques, and/or stream enhancement/restoration activities. These removal estimates were determined using STEPL. For this analysis, the high priority riparian buffer sites on non-agricultural lands within the watershed were determined through GIS by selecting all high priority riparian sites and then removing all properties with agricultural lands to ensure that these parcels had not already been used in agricultural and riparian buffer sediment reductions. See Appendix G for more information on STEPL calculations for sediment removal using riparian buffers.

Formula 21: Estimated Total Possible Riparian Buffer Phosphorus Reductions in the Watershed

Estimated Total Possible Phosphorus Removal in Watershed	=	Phosphorus Removal Per Typical Riparian Buffer Restoration	x	Number of Non-Ag High Priority Riparian Buffer Restoration Sites in the Watershed
39,760 lbs/year	=	140 lbs/year	x	284

Formula 22: Estimated Total Possible Riparian Buffer Nitrogen Reductions in the Watershed

Estimated Total Possible Nitrogen Removal in Watershed	=	Nitrogen Removal Per Typical Riparian Buffer Restoration	x	Number of Non-Ag High Priority Riparian Buffer Restoration Sites in the Watershed
353,580 lbs/year	=	1,245 lbs/year	x	284

7.2.4) Septic Repair/Replacement Nutrient Load Reductions

Nutrient removal estimates for septic systems represent nutrient loading prevented from impacting waterways if impaired septic systems are repaired or replaced. These removal estimates were determined using SCDHEC's standards for septic systems (see Appendix B). The estimated nutrient removal rates are based on the 3,019 estimated failing septic systems in this watershed (Table 16).

Formula 21: Estimated Total Possible Septic Phosphorus Reductions in the Watershed

Estimated Total Possible Phosphorus Removal in Watershed	=	TP Removal Per Typical Septic Repair	x	Estimated Number of Failing Septic Systems
36,831.8 lbs/year	=	12.2 lbs/year	x	3,019

Formula 21: Estimated Total Possible Septic Nitrogen Reductions in the Watershed

Estimated Total Possible Nitrogen Removal in Watershed	=	TN Removal Per Typical Septic Repair	x	Estimated Number of Failing Septic Systems
93,890.9 lbs/year	=	31.1 lbs/year	x	3,019

7.2.5) Total Recommended Nutrient Reductions and BMPs

To reach the total possible annual nutrient reduction of 296,781,975 lbs/year (148,3901 tons/year) using septic, agricultural, land protection, and riparian buffer restoration BMPs, a very large number of projects would have to be completed. For example, it would take the installation of an agricultural BMP bundle on all 676 identified high priority sites for agricultural BMPs (see Section 12) to meet the total possible annual nutruent reductions of 17,576 pounds. Additionally, based on the total acreage of identified high priority parcels (see Section 12), nearly 12,800 acres would need to be protected to meet the total possible annual nutrient reductions for land protection. Table 25 summarizes the calculations in sections 7.2.1 – 7.2.3 and the number of projects required to meet the total possible annual nutrient load reductions.

Table 25. Total Possible Annual Nutrient Reductions

	BMP	Standard TP Removal per BMP	# of Projects	Total Possible Annual Reductions (tons/year)	Total Possible Annual Reductions (lbs/year)
Total Phosphorus (TP)	**Agricultural BMPs bundle**	5 lbs/year	676	1.69 tons/year**	3,380 lbs/year
	Land Protection	2.6 tons/acre/year	12,768.98 acres	33,199.35 tons/year	66,398,696 lbs/year*
	Riparian Buffer Restoration	140 lbs/year	284	19.88 tons/year**	39,760 lbs/year
	Septic Repair/ Restoration	31.1 lbs/year	3,019	18.42 tons/year**	36,831.8 lbs/year
	Total			**33,239 tons/year**	**66,478,668 lbs/year**
	BMP	**Standard TN Removal per BMP**	**# of Projects**	**Total Possible Annual Reductions (tons/year)**	**Total Possible Annual Reductions (lbs/year)**
Total Nitrogen (TN)	**Agricultural BMPs bundle**	21 lbs/year	676	7.098 tons/year**	14,196 lbs/year
	Land Protection	9 tons/acre/year	12,768.98 acres	114,920.82 tons/year	229,841,640 lbs/year*
	Riparian Buffer Restoration	1,245 lbs/year	284	176.79 tons/year**	353,580 lbs/year
	Septic Repair/ Restoration	12.2 lbs/year	3,019	46.9 tons/year**	93,890.9 lbs/year
	Total			**115,152 tons/year**	**230,303,307 lbs/year**

* The numbers in these cells were converted from tons to pounds by multiplying Totals by 2000
**The numbers in these cells were converted from pounds to tons by multiplying Totals by 0.0005

As mentioned in Section 7.1, the watershed contributes 97,326.8 pounds of phosphorus per year and 537,787.4 pounds of nitrogen to the region (total of 635,114.20 lbs/year) with the majority of the loading attributed to pasturelands and urban development. Table 26 outlines the approximate number of BMPs recommended to achieve a reduction of this amount. These estimations were derived using the standard annual nutrient removal rates for each BMP multiplied by the suggested number of BMPs in the watershed to attain the necessary reductions. The recommended numbers for Septic Repairs/Replacements and Agricultural BMPs were taken from the recommended number of projects to meet bacteria load reductions (Section 5.4), and the recommended number for Land Protection was taken from the total annual recommended sediment reductions (Section 6.2.4).

Table 26. Total Annual Recommended Nutrient Reductions and BMPs

BMP	Standard TP Removal per BMP	Standard TN Removal per BMP	# of Projects	Total Nutrient Reduction Per BMP (lbs/year)
Septic Repair/Replacement	12.2 lbs/year	31.1 lbs/year	60	2,598 lbs/year
Agricultural BMPs bundle	5 lbs/year	21 lbs/year	12	312 lbs/year
Land Protection	2.6 tons/acre/year (5,200 lbs/acre/year)	9 tons/acre/year	55 acres	1,276,000 lbs/year*
Riparian Buffer Restoration	140 lbs/year	1,245 lbs/year	5	6,925 lbs/year
Total				**1,285,835 lbs/year**

* The numbers in these cells were converted from tons to pounds by multiplying Totals by 2000

8) LOAD REDUCTIONS SUMMARY AND COST ESTIMATES

As summarized in Table 27, the annual recommended load reductions for bacteria, sediment, and nutrients would be met with the implementation of Septic, Agricultural, Land Protection, and Riparian Buffer Restoration projects. Although nutrient loading would be met with only 30 acres of protected land, meeting sediment load recommendations necessitates the protection of 55 acres which exceeds the nutrient loading recommendations. Additionally, because bacteria load reduction recommendations are 60 septic and 12 agricultural projects, those numbers were used in the sediment and nutrient load reduction considerations.

Table 27. Annual Load Reductions and Recommended BMPs in the Three and Twenty Creek Watershed

BMP	# of Projects	Bacteria Load Reduction (counts/year)	Sediment Load Reduction (tons/year)	Nutrient Load Reduction (lbs/year)
Septic Repair/ Restoration	60	1.45E+12	n/a	2,598
Agricultural BMPs bundle	12	1.94E+14	48	312
Pet Waste Stations	5	1.10E+13	n/a	n/a
Land Protection	55 (acres)	n/a	11,258.5	1,276,000
Riparian Buffer Restoration	5	n/a	0.13	6,925
Total		**2.07E+14 counts/year**	**11,306.5 tons/year**	**1,285,835 lbs/year**

The cost of implementing the recommended projects above is significantly less costly than implementing all possible load reduction projects. For example, 3,019 septic restoration projects would need to be implemented in order to meet all possible load reductions in the watershed, however, only 10 are needed to meet the requirements of the TMDL; this is a cost difference of over $12 million. According to the State of Oregon's Department of Environmental Quality (Oregon DEQ Watershed Management, 2010), the average cost of an urban riparian buffer restoration project is $10,543 per acre; the average size of non-agricultural high priority parcels

for riparian buffers in the Three and Twenty Watershed is five acres, bringing the average riparian buffer enhancement/restoration project cost to $52,715. Land protection costs can vary significantly, but Upstate Forever's Land Trust estimates a cost of $23,250 per acre to close a conservation easement, with a minimum acreage of 55 acres. In sum, the total cost of implementing the recommended BMPs is $2,015,809, which is nearly $45 million less than if all possible projects were implemented.

Table 28. Cost Estimates for Recommended Project Implementation in the Three and Twenty Creek Watershed

BMP	Average Cost	Possible Projects	Possible Cost	Recommended Projects	Estimated Cost
Septic Repair/ Restoration	$4,000	3019	$12,076,000	60	$240,000
Agricultural BMPs bundle	$19,332	676	$13,068,432	12	$231,984
Pet Waste Stations	$300	3,206	$961,800	5	$1,500
Land Protection	$23,250	255	$5,937,576	55 acres	$1,278,750
Riparian Buffer Restoration	$52,715	284	$14,971,060	5	$263,575
Total			**$47,014,868**		**$2,015,809**

9) PARCEL PRIORITIZATION METHODOLOGY

UF utilized weighted criteria to analyze each parcel within the Three and Twenty Creek Watershed in order to identify priority lands for protection, restoration/enhancement, and/or best management practices. Each criterion was assigned a total number of possible points based on its importance to water quality protection. Cumulative points for each parcel were used to identify the parcels most important to protecting or improving water quality. Parcels that are already protected/preserved through conservation easements, national, state, or city/county parks, or owned by conservation organizations were removed from the protection analysis; all parcels were included in the restoration and BMP analyses. The results identify lands that should be protected or improved to provide the most benefit to water quality. The criteria and associated point system were analyzed using GIS and available data layers.

9.1) Preliminary Steps

Step 1: Parcel Layer Pre-conditioning in ArcGIS

Before beginning the analysis, it was important to normalize the parcel layers from each of the two counties within the watershed areas. After selecting all of the parcels that lie fully or partially within the watershed, a new merged layer was created that combined the selected parcels from each county. If appropriate, parcel boundaries were clipped to eliminate areas outside the watersheds' boundaries and each parcel's acreage within the focus area was calculated.

- *Steps taken:*
    - Add parcel layers for each county within the watershed boundary.
    - Select all parcels fully/partially within the watersheds, creating new layers for each county.

- Merge selected parcels from each county into one shapefile.
- Clip merged parcel layer to the watersheds' boundaries.
- In a new field, calculate geometry to find the area of each parcel.

This conditioned layer will be referred to as "parcel layer" or "parcel" through the remainder of this report.

Step 2: Parcel Layer Analysis in ArcGIS – The parcel layer was then analyzed to identify high priority parcels for protection, restoration/enhancement, or BMPs, based on various factors that are important to water quality; specific details are provided throughout the report.

Step 3: Analyzing Results in Excel – The results from the Protection, Restoration/Enhancement, and BMP analyses were exported from the parcel layer's ArcGIS attribute table into an Excel spreadsheet for further review and refinement.

9.2) Scoring Methodology

Scoring of individual criteria was weighted based on importance to water quality in each category. Relevant criteria were evaluated, points were assigned to each parcel as appropriate, and the points were summed for each parcel in each category. Some criteria were included in multiple categories. The end result is a score for each parcel in each category. A higher point value indicates increased importance to water quality within each category (Protection, Restoration/Enhancement, BMPs).

9.3) Analyzing and Refining Results

The results identify the high priority parcels for actions to protect and improve water quality. If the analysis identified a large number of parcels as "high priority" the results were further refined to provide an actionable strategic plan for initial implementation. Specific refinement strategies varied and are discussed within the individual results and recommendations sections. Implementation of these cost-effective actions will help protect and improve water quality. An overview of the actions analyzed is shown in Table 29. The results are presented in summary, condensed table, and map formats. Full spreadsheet data will be provided electronically for each category.

9.4) Land Prioritization Categories

Parcels in the Three and Twenty Creek Watershed were analyzed in nine categories utilizing the parcel prioritization methodology (Table 29). While the Land Protection category focuses on high-quality existing lands that are recommended for protection in their current state, the remaining eight categories focus on lands most important for restoration practices specific to each category.

Table 29. Land Prioritization Categories and Summary of Results

Category	# of Parcels in Results	Summary of Category's Main Goal
 Land Protection	87	Protecting lands that remain in good condition or may be currently providing significant benefits to water quality and will help mitigate future impairments or loss of benefits. If developed, these lands would have the biggest impact on water quality.
 Septic System Repair/ Replacement	2,769	Identifying parcels with septic systems that may be attributing sources of bacteria impairments.
 Agricultural BMPs	676	Identifying agricultural parcels that may be contributing sources of bacteria or sediment pollution for the implementation of agricultural BMPs
 Wetland Restoration and Enhancement	66	Identifying parcels containing impacted, low quality, or inundated wetlands that could provide additional water quality benefits if restored or enhanced to a higher quality wetland.
 Riparian Buffer Restoration and Enhancement	537	Identifying parcels with highly sensitive riparian buffers that, if restored, would provide significant water quality benefits such as slowing and filtering stormwater runoff, reducing flooding, stabilizing streambanks, and minimizing erosion.
 Voluntary Dam Removal	9	Identifying parcels containing dams that may be suitable for voluntary dam removal at the property owner's discretion and approval if the owner is no longer receiving enough benefits to outweigh the liability and maintenance responsibilities.
 Shoreline Management	145	Identifying parcels adjacent to drinking water reservoirs or intakes that are high priority for shoreline management BMPs with the end goal of reducing pollutants directly entering drinking water sources.
 Stormwater BMPs	168	Identifying parcels within developed areas that may be appropriate for installation of stormwater retrofits, which would reduce stormwater runoff and pollutant loading into nearby waterways in an urbanized setting.
 Pet Waste Stations	12	Identifying parcels that may be suited for the installation of a pet waste stations to encourage proper disposal of pet waste and reduce bacteria loadings from pets, targeting high traffic pet locations such as parks or veterinary offices.

10) LAND PROTECTION

The goal of this analysis is to identify parcels that, if developed, would have the biggest impact on water quality. Protecting lands that remain in good condition or may be currently providing significant benefits to water quality can help mitigate future impairments or loss of benefits. Parcels that are already protected were removed from this analysis. Examples includes parks, Heritage Preserves, utility owned properties, and properties already known to be protected by a conservation easement.

10.1) Land Protection Criteria

Table 30 is an overview of the specific criteria and possible points that were used to evaluate each parcel. Each parcel's total score was used to determine those that are of high (20-31 points), medium (10-19 points), and low (0-9 points) priority for protection (see Figure 9). For a detailed overview of the criteria and scoring, please refer to Appendix F.

Table 30. Criteria and Ranking System for Land Protection Prioritization

Criteria	Ranking	Points	Total Possible Points per Category
Critical Watershed Area (CWA)	High Priority CWA	4	4
	Medium Priority CWA	3	
Stream Order	Headwater (1st and 2nd Order) Streams	4	4
Stream Classifications	ORW and TN Streams	4	4
	TGPT Streams	3	
	FW Streams with No Impairments	2	
	FW Streams with 1 or More Impairments	1	
Highly Sensitive Riparian Buffer Areas	43+ Acres of Riparian Buffers	4	4
	20-42.99 Acres of Riparian Buffers	3	
	8-19.99 Acres of Riparian Buffers	2	
	2-7.99 Acres of Riparian Buffers	1	
Forested Riparian Buffer Areas	Falls within the Highly Sensitive Riparian Buffer Area and has Forested Land Cover	1	1
Wetlands	FW Forested/Shrub, FW Emergent, Riverine Wetlands	3	3
	FW Pond and Lake Wetlands	2	
Hydric Soils	50+ Acres of Hydric Soils	3	3
	30-49.99 Acres of Hydric Soils	2	
	5-29.99 Acres of Hydric Soils	1	
100-Year Floodplain	100-Year Floodplain with no Urban/Developed Land	2	2
	100-Year Floodplain with Urban/Developed land	1	
Source Water Protection Areas	Source Water Protection Areas	2	2
Average Stream Length	Longer-than-Average Stream Length	2	2
Adjacency to Existing Protected Land	Adjacent to Existing Protected Land	1	1
Parcel Size	50 Acres or Larger	1	1
TOTAL POSSIBLE PROTECTION POINTS PER PARCEL			**31**

10.2) Protection Results and Recommendations

Out of 31 points possible, the highest score a parcel achieved is 24. This analysis identified 179 parcels as high priority for protection in order to maintain the land in its current state (Figure 13). To further refine high priority results, parcels meeting the following qualifications were selected for more in-depth analysis:

1. 100 acres or greater
2. High priority for both Protection and Wetland Restoration
3. High priority for both Protection and Voluntary Dam Removal
4. Parcels with 50 acres or greater non-urban land cover (50+ acres of agricultural, forested, or existing riparian buffer coverage)
5. Parcels were REMOVED if: use is a golf course or university

The refined results identified 87 parcels for initial protection efforts. These parcels are located throughout the Three and Twenty watershed and 62% of the high priority parcels are 100 acres or more (see Figure 14). Only one parcel scored 24 points, located on Steel Creek. Concentrations of high priority parcels for protection are located along Six and Twenty Creek, Jones Creek, and Three and Twenty Creek. General land protection strategies are outlined below and specific recommendations for each parcel are included in Table 32: High Priority Parcels for Protection.

10.3) Land Protection Strategies and Potential Funding Sources

Land protection can be accomplished through a variety of mechanisms and funding sources. The following are suggested land protection strategies and cost share programs that could be utilized in the Three and Twenty watershed to protect sensitive lands in the region.

10.3.1) Conservation Easement

A conservation easement is a voluntary contract between a landowner and a qualified land trust, which allows the landowner to legally restrict certain land uses from occurring on their property. These agreements are permanent and remain with the land even after it has been sold or willed to heirs. Based on information obtained from UF's Land Trust, it is estimated that the total cost estimated for an easement totals $6,250 for staff time and fees. Stewardship fees for the property, which involve the annual monitoring of the property in perpetuity, typically have ranged between $9,500 - $17,000 in total depending upon numerous factors including size of tract and distance from office.

10.3.2) Deed Restriction

While this option is discouraged, the current property owner could place restrictions on the deed to limit the allowable uses or development of the property, which could protect priority parcels. Deed restrictions are subject to enforcement by a third party that may not have the resources to ensure land is protected.

10.3.3) Fee Simple Purchase

Entities, such as ARJWS, could purchase priority parcels and voluntarily restrict certain undesirable land uses from occurring on their property. Restrictions could be permanent or temporary, depending on continued management and ownership decisions.

10.3.4) Land Donation

While this option would likely have limited availability, some current property owners may be interested in donating land, or a portion of their land, through a fee-simple donation, charitable contribution, donation with life estate, or bequest to an organization or business dedicated to stewarding the land for environmental benefits.

10.3.5) Water Utility Funded Watershed Protection Programs

Water utility funded watershed management plans are another alternative for protecting lands within source water protection areas. An example of such a program is the *Lake Maumelle and Lake Winona Management Plan* in Central Arkansas (Tetra Tech, 2007). It is well documented that what happens on the land impacts water quality, therefore land acquisition and management can be an effective tool for the protection of drinking water sources. For example, preserving lands around source waters can help reduce loading and impacts of nonpoint source pollution on drinking water sources, recharge streams and groundwater sources, reduce risk of hazardous spills, and lower overall treatment costs for operators (Trust for Public Land, 2004). Using this plan utilities can identify high priority lands for protection and/or restoration and then work with local communities and landowners to develop strategies to purchase the property and/or create a management plan for parcel.

Figure 13: Protected Land

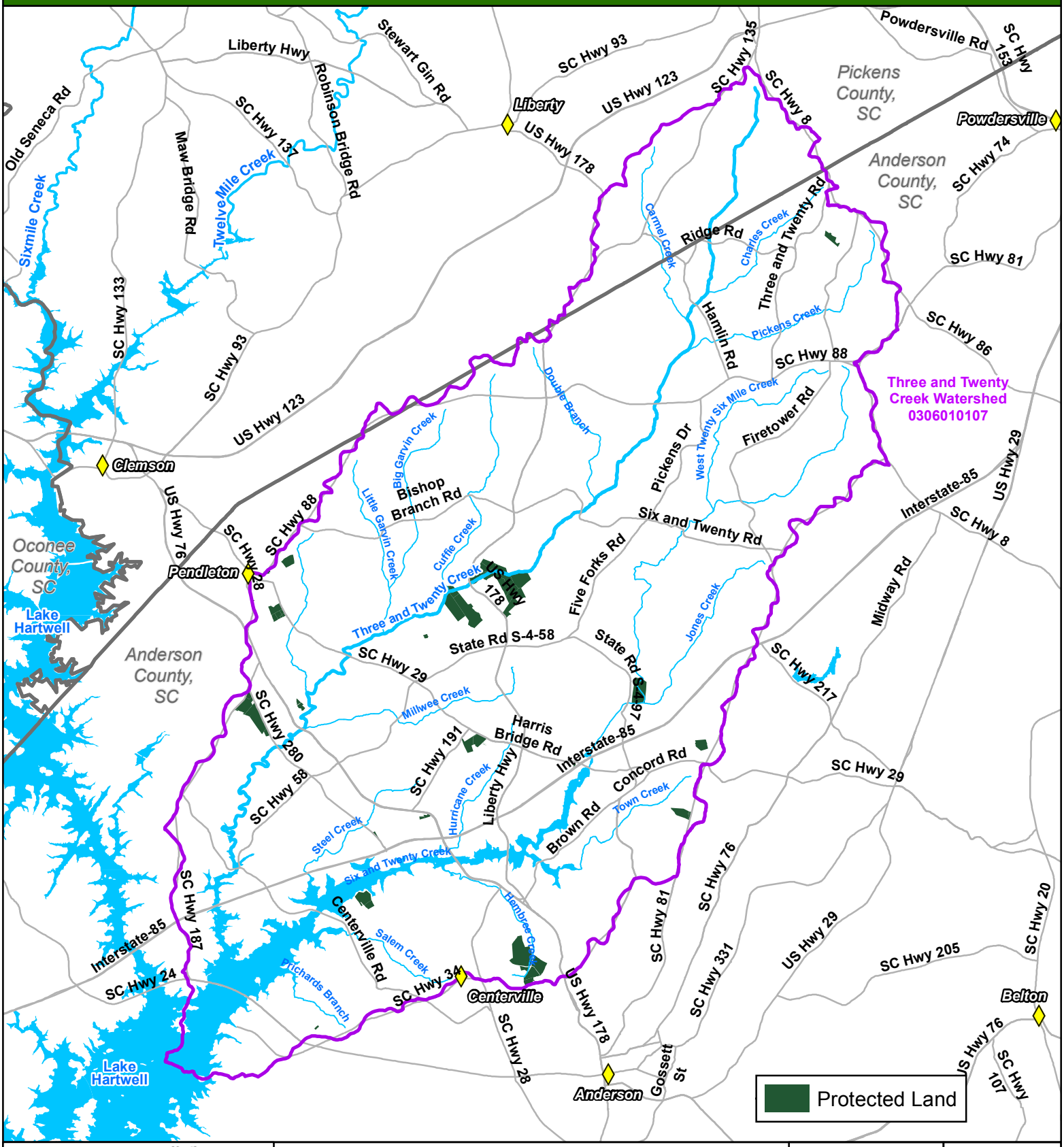

Figure 14: Parcel Prioritization for Protection

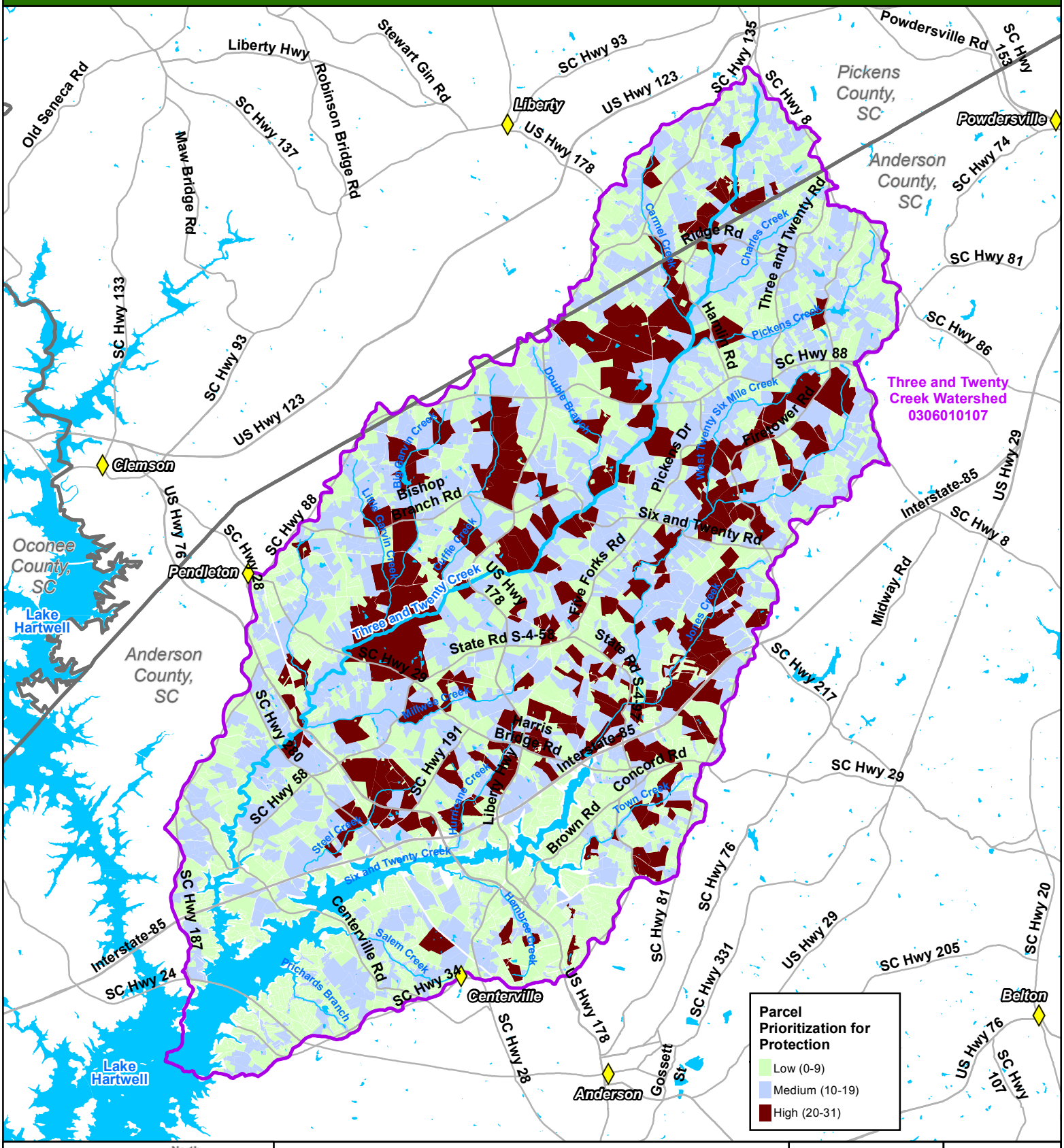

Figure 15: High Priority Parcels for Protection

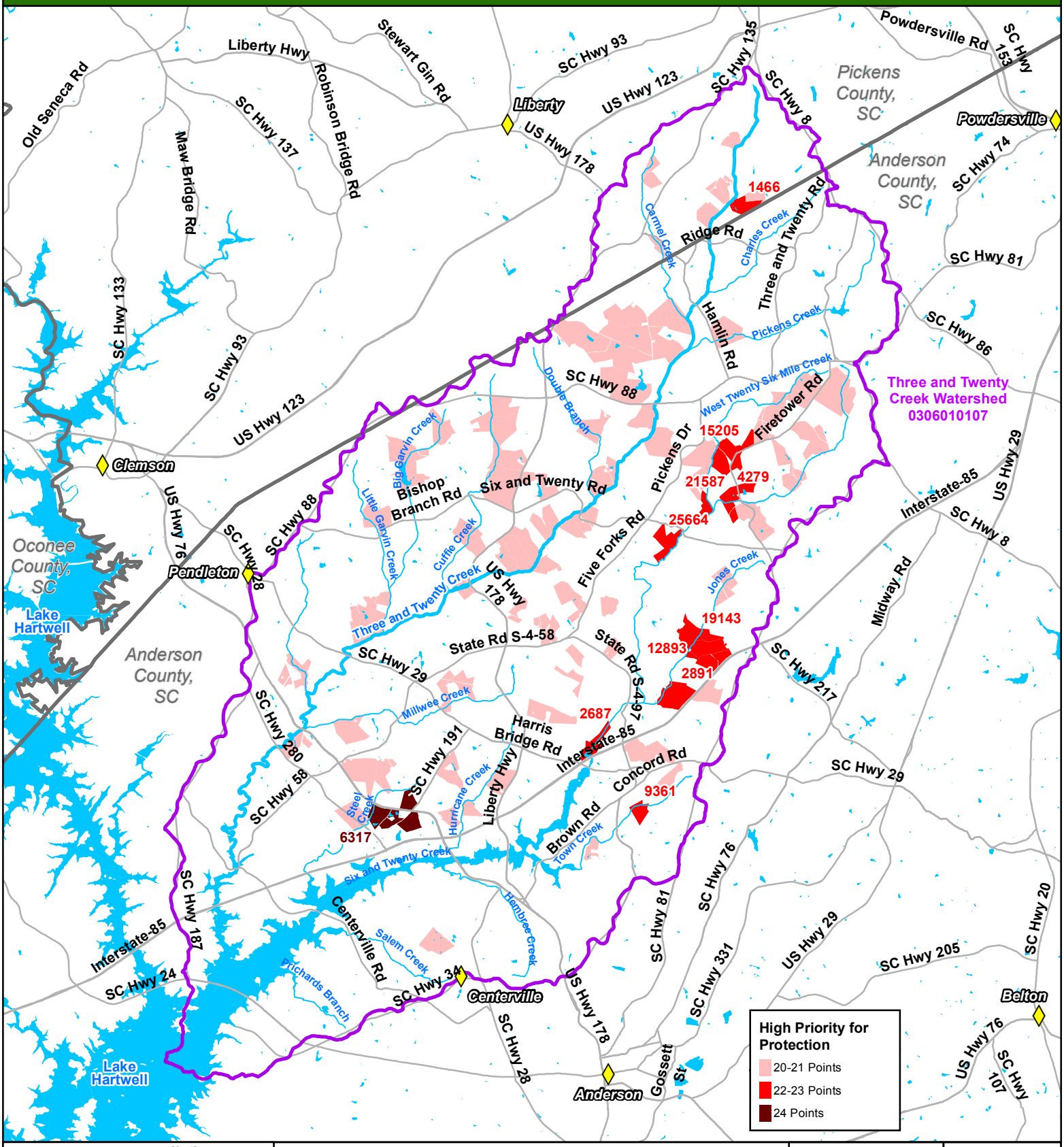

Table 31: HIGH PRIORITY PARCELS FOR LAND PROTECTION

MapID	Acreage	TaxPin	County	State	PropertyLocation	Prot_Score	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	Acres100	WetProt	ACEP	Wetland
6317	289.8099976	930001002	Anderson	SC	4906+4919 HIGHWAY 76	24	x									x			
19143	295.7919922	1430004016	Anderson	SC	305 POWER DR	23	x									x			
15205	242.9819946	1660001010	Anderson	SC		23	x									x			
2891	192.8070068	1440003001	Anderson	SC	1821 SHACKLEBURG RD	23	x									x			
4279	156.2839966	1670004001	Anderson	SC		23	x									x			
25664	137.0460052	1410008027	Anderson	SC		22	x									x			
12893	126.1240005	1430004002	Anderson	SC	100 RYOBI DR	22	x									x			
1466	104.5970001	5017-00-70-6482	Pickens	SC		22	x				x					x			
2687	102.435997	1180004017	Anderson	SC		22	x									x			
9361	72.6950989	1460001015	Anderson	SC	410 CATHY RD	22	x												
21587	68.435997	1410005011	Anderson	SC		22	x												
4768	1122.77002	1120002003	Anderson	SC	1420 RED BARN RD	21	x	x		x	x	x				x	x		
15858	438.0639954	1140007008	Anderson	SC	7205 LIBERTY HWY	21	x	x	x	x	x	x				x	x		
5065	265.8420105	1390001005	Anderson	SC	5917 OLD GREENVILLE HWY	21	x	x			x					x			
23723	234.4730072	1660005002	Anderson	SC		21	x									x			
21726	212.8470001	1660003003	Anderson	SC		21	x									x			
4324	210.798996	870006001	Anderson	SC		21	x	x	x	x	x					x	x		
15383	193.5200043	1640002036	Anderson	SC	500 HAMLIN RD	21	x	x								x			
18169	152.8450012	1140003014	Anderson	SC	1425 MELTON RD	21	x	x	x		x					x			
25000	149.9149933	1150005024	Anderson	SC	6914 LIBERTY HWY	21	x	x	x		x					x			
5691	142.173996	870002004	Anderson	SC		21	x	x	x	x	x	x				x	x		
7608	141.4340057	870006026	Anderson	SC		21	x	x	x	x	x	x				x	x		
7202	138.173996	1190001004	Anderson	SC	4665 LIBERTY HWY	21	x				x					x			
13154	131.4109955	1450002001	Anderson	SC	1210 DALRYMPLE RD	21	x									x			
15920	122.737999	1170001001	Anderson	SC	360 MURPHY RD	21	x	x	x		x					x			

Parcels sorted by Protection Score, highest to lowest. This table includes only the top 25 parcels.

11) SEPTIC SYSTEM REPAIR OR REPLACEMENT

Damaged or improperly maintained septic systems can be a significant source of bacteria to surface and groundwater resources. Improper connections, clogs, heavy use, or unmaintained systems can increase the chance that improperly treated wastewater will leak into surface and ground water, which can significantly increase pathogenic bacteria levels, leading to potential health effects in drinking water. Septic tanks should be pumped every 5 years to maintain efficiency. Septic system repairs and replacements can reduce bacteria pollution in nearby streams by preventing bacteria leakage from faulty systems. The estimated failure rate for septic systems is 20% (U.S EPA, 2002).

11.1) Septic System Repair/Replacement Criteria

Table 32 is an overview of the specific criteria and possible points that were used to evaluate each parcel. Each parcel's total score was used to determine those that are of high (7-10), medium (4-6), and low (0-3) priority for septic tank repair/replacement (see Figure 16). For a detailed overview of the criteria and scoring, please refer to Appendix F.

Table 32. Criteria and Ranking System for Septic Repair/Replacement

Criteria	Ranking	Points	Total Possible Points per Category
Sewer Service Availability (prerequisite for further analysis)	Parcels without Sanitary Sewer Lines	1	1
Adjacency to Drinking Water Reservoirs or Intakes	Adjacent to Drinking Water Reservoirs or Intakes	4	4
	Adjacent to other Waterways	2	
Current Water Quality Impairments	Include, Adjacent to, or Upstream of Existing Impairments	3	3
Land Cover	Urban/Developed Land	2	2
TOTAL POSSIBLE SEPTIC POINTS PER PARCEL			**10**

11.2) Septic System Results and Recommendations

This analysis identified 2,769 parcels as high priority for septic repair/replacement (Figure 17). Concentrations of high priority parcels can be seen in the upper portion of the Lower Three and Twenty Creek Watershed (030601010702), the Upper Three and Twenty Creek Watershed (030601010701), and along the shoreline of Lake Hartwell. UF recommends a public outreach campaign targeting neighborhoods in high priority areas; this will target homeowners that are likely unable to obtain sewer service and may have problematic septic tanks.

11.3) Septic System Strategies

According to the U.S EPA STEPL Model, a typical septic system generates 2.42E+10 bacteria a year (SCDHEC, 2015). The following BMPs are considered the most relevant and effective for residential areas in the watershed for bacteria pollution relating to wastewater.

11.3.1) Replace/Repair Septic System

Replacing and/or repairing malfunctioning septic systems is recommended throughout these watershed. Repairing these systems not only improves water quality but also improves quality of life for residents dealing with these failing septic systems.

Example of Septic Tank Replacement

Example:Septic Tank Maintenance: Before and After

11.3.2) Extending Sewer Lines

In regions with a high concentration of failing septic systems, extending municipal sewer lines to areas of concern may be the most cost-effective long-term solution. Careful consideration and analysis should be given to this before it is viewed as a viable option.

11.4) Septic System BMP Unit Cost Estimates and Funding Options

Many homes are not within access points of municipal sanitary sewer lines and therefore an onsite septic system is the most appropriate wastewater treatment. Traditional septic systems and drain fields can work well if properly installed and maintained, but replacements and repairs are sometimes necessary. The following table outlines the cost estimates and funding options for septic BMPs (Table 33).

Table 33. Septic System BMP Unit Cost and Potential Funding Sources

Nonpoint Sources of Bacteria Pollution	BMP	Estimated BMP Unit Cost	Potential Funding Sources
Septic Tanks	• Replace/repair onsite failing septic systems and leach fields • Tie into existing sewer line	$4,000 per system	• SCDHEC 319 Funds • USDA Rural Development • State Revolving Funds

There are a few cost share programs available for homeowners to assist with septic system repair and replacements. The costs for extending sewer lines are not included in this plan as these expenses are contingent upon many factors including depth to pipe, bedding materials, and

potential easement costs. If the situation warrants the extension of sewer the local sewer provider will be able to provide a more accurate estimate of total costs of the project prior to construction.

11.4.1) Section 319 Funding (SCDHEC)

The U.S EPA provides annual funding to SCDHEC for projects that reduce or prevent nonpoint source water pollution by implementing an approved Watershed-Based Plan. SCDHEC distributes these Section 319 funds through grants that may pay up to 60 percent of eligible project costs, with a 40 percent non-federal match, typically provided by the homeowner.

11.4.2) Local Governments

Both Anderson and Pickens Counties may be able to assist homeowners by providing financial support for septic system improvements as funding becomes available. Additionally, local sewer authorities may be able to aid with onsite septic system maintenance, repairs, or replacements.

11.4.3) USDA Rural Utilities Service – Water and Environmental Programs

The Rural Utilities Service provides financial assistance to eligible organizations for projects involving water, wastewater, and solid waste disposal systems in rural areas. Technical assistance by state is given to non-profit organizations to provide water and waste disposal-related technical assistance and/or training to rural water systems, and towns and cities with a population of 10,000 or less. The revolving fund program is also given to non-profits to assist rural communities with water/wastewater systems through a lending program.

11.4.4) USDA Rural Development Office

The Section 504 Very Low-Income Housing Repair Program offers low-interest loans to rural residents who earn less than 50% of the area median income. Moderate income is defined as "the greater of 115% of the U.S. median family income or 115% of the average of the state-wide and state non-metro median family incomes, or 115/80ths of the area low-income limit" (USDA, 2017). The moderate-income limit for the watershed is $78,200 for 1-4-person homes and $103,200 for 5-8+ person homes. The average median income for the watershed is $51,743. Of the 69 census block groups in the watershed, 91% have median incomes below the moderate-income limit. These low-interest loans are to be used specifically to render the home more safe or sanitary. Additionally, this program offers grants to elderly very-low-income homeowners to remove health and safety hazards. Homeowners over 62 years of age may be eligible for these grant funds.

Figure 16: Parcel Prioritization for Septic Repair/Replacement

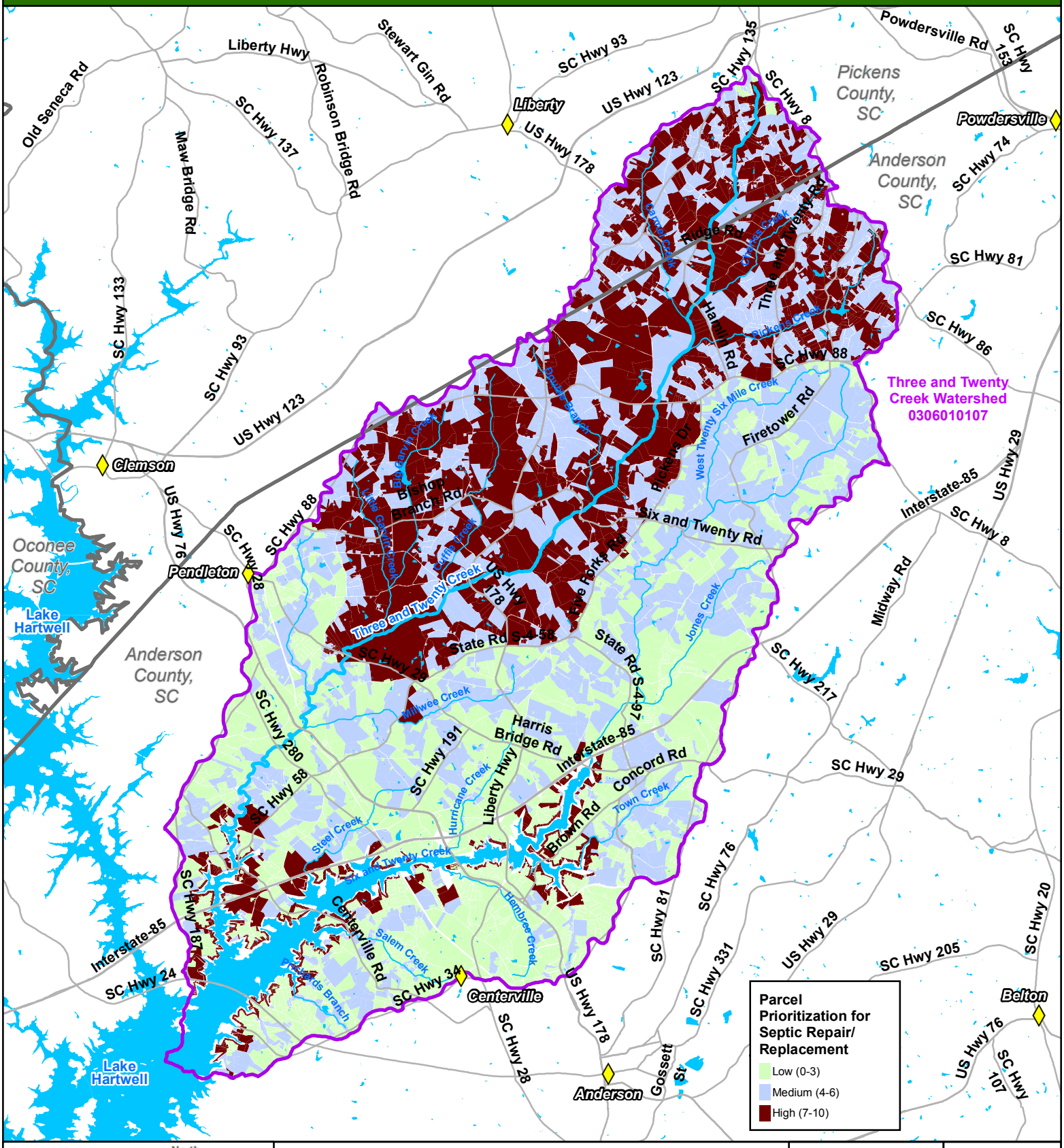

Figure X: High Priority Parcels for Septic Repair/Replacement

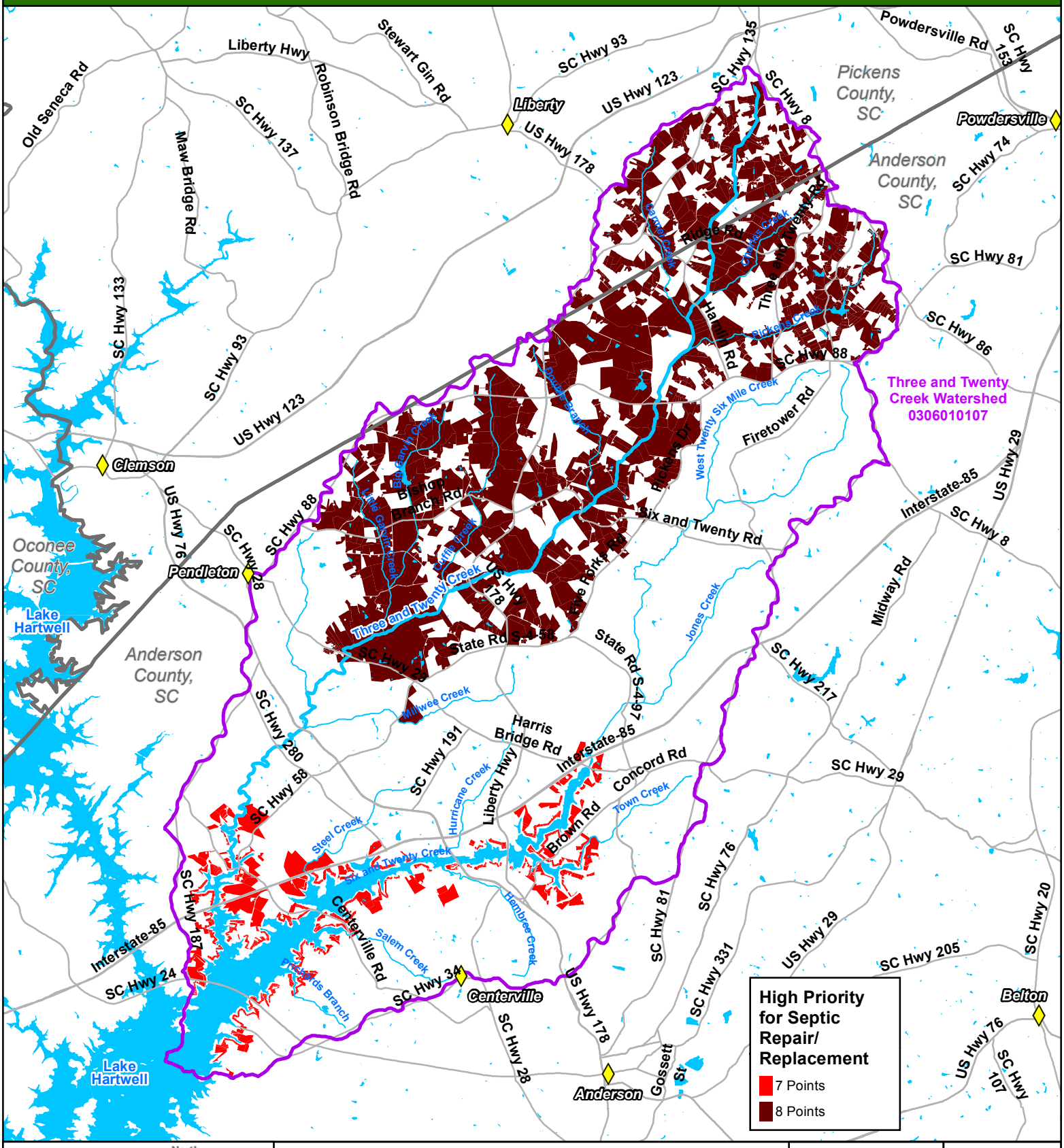

Table 34: HIGH PRIORITY PARCELS FOR SEPTIC REPAIR/RESTORATION

MapID	TaxPin	County	State	PropertyLocation	Septic_Score	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	Acres100	WetProt	ACEP	Wetland
4768	1120002003	Anderson	SC	1420 RED BARN RD	8	x	x		x	x	x				x	x		
15858	1140007008	Anderson	SC	7205 LIBERTY HWY	8	x	x	x	x	x	x				x	x		
17828	620004029	Anderson	SC	1514 CHERRY ST EXT	8	x	x	x	x	x					x	x		
4324	870006001	Anderson	SC		8	x	x	x	x	x					x	x		
2299	1380001018	Anderson	SC	1020 SLAB BRIDGE RD	8	x	x	x	x	x					x	x		
5440	610005005	Anderson	SC	533 BISHOPS BRANCH RD	8	x	x	x	x	x					x	x		
6606	1160002008	Anderson	SC	205 JERRY DALRYMPLE DR	8	x	x	x	x	x					x	x		
5691	870002004	Anderson	SC		8	x	x	x	x	x	x				x	x		
7608	870006026	Anderson	SC		8	x	x	x	x	x	x				x	x		
2308	1400002001	Anderson	SC	113 GRIFFITH DR	8	x	x	x	x	x					x	x		
12554	880005024	Anderson	SC	512 LINK RD	8	x	x	x	x	x						x		
14517	1390001003	Anderson	SC		8	x	x		x	x	x					x		
18293	890004036	Anderson	SC	6415 LIBERTY HWY	8	x	x	x	x	x						x		
1397	5017-00-41-7684	Pickens	SC	959 ZION SCHOOL RD	8	x	x	x	x							x		
1266	5016-00-39-7695	Pickens	SC	1195 ZION SCHOOL RD	8	x	x	x	x							x		
20936	1140006007	Anderson	SC	646 MELTON RD	8	x	x	x	x	x						x		
1426	5017-00-52-5654	Pickens	SC		8	x	x	x	x							x		
511	5006-02-85-3948	Pickens	SC		8	x	x	x	x							x		
1265	5016-00-38-5653	Pickens	SC		8	x	x	x	x							x		
5065	1390001005	Anderson	SC	5917 OLD GREENVILLE HWY	8	x	x			x					x			
9365	1400002037	Anderson	SC		8	x	x								x			
15383	1640002036	Anderson	SC	500 HAMLIN RD	8	x	x								x			
10566	1140007007	Anderson	SC	7385 LIBERTY HWY	8	x	x			x					x			
15916	1140007001	Anderson	SC		8	x	x			x					x			
18169	1140003014	Anderson	SC	1425 MELTON RD	8	x	x	x		x					x			

Parcels sorted by Septic Score, highest to lowest. This table includes only the top 25 parcels.

12) AGRICULTURE

Implementing agricultural BMPs reduces bacteria and sediment pollution in nearby streams while maintaining, and often improving, conditions for livestock. For the purposes of this plan agricultural land includes pasture (livestock), hay, and cultivated crops. Livestock are the primary agricultural source of bacterial pollution throughout the planning area and can also contribute to sediment pollution. Therefore, to address bacteria inputs agricultural BMPs will focus on restricting animal access to streams across the region with the exception of the urban areas around the City of Anderson, Town of Pendleton, and along the major transportation corridors (I-85, SC-28, SC-29, SC-24, etc.). When fencing livestock out of streams, it is often necessary to provide an alternative water source for the animals if the stream was their primary source of water; consequently, agricultural BMPs often require several components such as a combination of exlusion fencing and alternative watering sources.

12.1) Agricultural BMP Criteria for Parcel Prioritization

Examples of agricultural BMPs include: fencing livestock out of streams, improving heavy use areas, stabilizing streambanks, providing alternative watering sources, and adding riparian buffers. Table 35 is an overview of the specific criteria and possible points that were used to evaluate each parcel. Each parcel's total score was used to determine those that are of high (12-17), medium (6-11), and low (0-5) priority for agricultural BMPs (see Figures 18 and 19). For a detailed overview of the criteria and scoring, please refer to Appendix F.

Table 35. Criteria and Ranking System for Agricultural BMPs

Criteria	Ranking	Points	Total Possible Points per Category
Land Cover (prerequisite for further analysis)	50% or greater Agricultural Land Cover	2	4
	Agricultural Land Adjacent to Streams	2	
Current Pollutant Export (for each Nitrogen, Phosphorus, and Sediment)	High Range of Export	3	9 (3 point maximum for each pollutant)
	Medium Range of Export	2	
Current Water Quality Impairments	Include, Adjacent to, or Upstream of Existing Impairments	3	3
Permitted and Unpermitted Point Source Pollutants	Unpermitted Point Sources (farms)	1	1
	Permitted Point Sources (CAFO's, biosolid application areas, Animal Management Areas)	1	
TOTAL POSSIBLE AGRICULTURAL POINTS PER PARCEL			**17**

12.2) Agricultural BMP Results and Recommendations

This analysis identified 676 parcels as high priority for Agricultural BMPs. High priority parcels are concentrated in the northern portion of Lower Three and Twenty Creek Watershed (030601010702), along the middle and northern portion of Three and Twenty Creek, and in the

northern portion of the Upper Six and Twenty Creek Watershed (030601010703). UF recommends targeting landowners in these areas for Agricultural BMP installations.

12.3) Agricultural BMP Strategies

The following is a list of BMPs considered the most relevant and effective for agricultural areas in the watershed for bacteria and sediment pollution. While they are defined separately, they are most often installed in combination.

12.3.1) Streambank Fencing

Installing fences limits livestock access to waterways. This practice ensures that manure is not deposited directly into streams or ponds, protects riparian vegetation, and reduces erosion along streambanks.

Examples of Streambank Fencing

12.3.2) Armored Streambank Crossings /Culvert Crossing

When stream crossings are necessary to move livestock from one area to another, armored streambank crossings and culvert crossings provide protection to reduce erosion within the crossing area. The type of crossing needed will depend upon site conditions.

Example of Armored Streambank Crossing

12.3.3) Alternative Watering Sources/Wells and Linear Pipeline

Streams and ponds in pastures are often used as the primary watering source for livestock. If fences restrict livestock's access to water, an alternative watering source will be needed. Alternative watering sources support removal of livestock from waterways, therefore reducing manure deposited directly into streams, protecting riparian vegetation, and reducing erosion

along streambanks. Additionally, providing a clean reliable source of water improves livestock health and reduces risk of mortality from injury or disease. Linear pipelines may be necessary to transport water from the well to the alternative watering sources.

Examples of Alternative Watering Source with Linear Pipeline

12.3.4) Animal Heavy Use Areas

It is often difficult to maintain vegetation in heavy animal use areas, such as alternative water sources. Installing a durable material (e.g., crush and run gravel) reduces erosion and pollutant loading of stormwater runoff, and can be an alternative to maintaining vegetation.

Examples of Animal Heavy Use Areas

12.3.5) Riparian Buffers

Riparian buffers are vegetated areas along waterways that stabilize soil, filter runoff, and provide wildlife habitat. Restoring riparian buffers will reduce manure, sediment, fertilizers, pesticides, and other pollutants from washing into streams, stabilize streambanks, and improve water quality.

Example of Riparian Buffers in Agricultural Setting

12.4) Agricultural BMP Unit Costs Estimates and Funding Options

Agricultural BMP unit cost estimates are based on information provided by the USDA (SC EQIP, 2017). There are numerous cost share programs available to landowners at the federal, state, and local level. The US Department of Agriculture, including the Natural Resources Conservation Service (NRCS) and Farm Service Agency (FSA), implements many voluntary programs that help reduce bacteria loading by establishing riparian buffers, protecting wetlands, and conserving water resources. Additional details are included below.

Table 36. Agricultural BMP Unit Costs (SC EQIP, 2017)

BMP	Estimated Cost Per Unit
Linear Streambank Fencing	$3.30/ft.
Well (500' deep)	$9,546.25 each
Linear Pipeline	$4.92/ft.
Alternative Watering Source	$1066.40 each
Heavy Use Area	$1.67 sq. ft.
Riparian Buffer	$389.07/acre
Filter Strip	$167.37 ft.

12.4.1) Conservation Steward Program (CSP)

CSP is a voluntary program funded through the NRCS that provides financial and technical assistance to eligible producers to conserve and enhance soil, water, air, and related natural resources on their land. Eligible projects include cropland, grassland, prairie land, improved pastureland, rangeland, non-industrial private forest lands, agricultural land under the jurisdiction of an Indian tribe, and other private agricultural land (including cropped woodland, marshes, and agricultural land used for the production of livestock) on which resource concerns related to agricultural production could be addressed (NRCS SC, 2018).

12.4.2) Conservation Reserve Program (CRP)

The CRP is a land conservation program administered by the Farm Service Agency (FSA), a branch of the US Department of Agriculture. Farmers enrolled in the program agree to remove environmentally sensitive land from agricultural production and plant species that will improve environmental health and quality in exchange for an annual rental payment. Contracts for land enrolled in CRP are 10-15 years in length. The long-term goal of the program is to re-establish valuable land cover to help improve water quality, prevent soil erosion, and reduce loss of wildlife habitat (USDA, 2018).

12.4.3) Environmental Quality Incentive Program (EQIP)

The NRCS EQIP program promotes agricultural production while maintaining or improving environmental quality. Typically, up to a 75 percent cost-share assistance is offered for project costs and forgone income. Historically underserved farmers can receive up to a 90 percent cost share. The specific priorities to be addressed on the property are:

- Improvement of water quality in impaired waterways;
- Conservation of ground and surface water resources;
- Improvement of air quality;
- Reduction of soil erosion and sedimentation; and
- Improvement or creation of wildlife habitat for at-risk species.

12.4.4) Agricultural Water Enhancement Program (AWEP)

Within EQIP, AWEP provides additional funding to NRCS offices to provide technical and financial assistance to agricultural producers to implement water enhancement activities on agricultural land to conserve surface and groundwater and improve water quality. Examples of previously funded projects include high efficiency irrigation systems, nutrient and pest management plans, and agricultural BMPs.

12.4.5) Section 319 Funding

The EPA provides annual funding to SC DHEC for projects that reduce or prevent nonpoint source water pollution by implementing an approved Watershed-Based Plan. SCDHEC distributes these Section 319 funds through grants that will pay up to 60 percent of eligible project costs, with a 40 percent non-federal match generally provided by the landowner.

12.4.6) Partners for Fish and Wildlife

The US Fish and Wildlife Service sponsors the Partners for Fish and Wildlife Program, which provides technical and financial assistance to conserve or restore native ecosystems. Cost share is determined by multiple factors including: project location, type of habitat being restored, species that will benefit (USFWS, 2018). This voluntary program primarily involves streambank fencing, tree-planting, and invasive species control. Projects on private lands must improve the habitat of Federal Trust species (i.e., migratory birds, threatened and endangered species, interjurisdictional fish, certain marine mammals, and species of international concern) for the principal benefit of the Federal Government. Program projects must be biologically sound, cost effective, and must include the most effective techniques based on state-of-the-art methodologies and adaptive management. These agreements are usually for a period of 10 years or more.

12.4.7) Wildlife Habitat Incentives Program (WHIP)

NRCS's WHIP program provides funding to landowners to devote some of their land to the development of wildlife habitat. Wildlife habitat may include upland, wetland, agricultural land, or aquatic habitat. The projects must target specific species for habitat improvement, and generally require an agreement of 5-10 years. Cost-share assistance is offered up to 75 percent, usually paid through reimbursements.

Figure 18: Parcel Prioritization for Agricultural BMP's

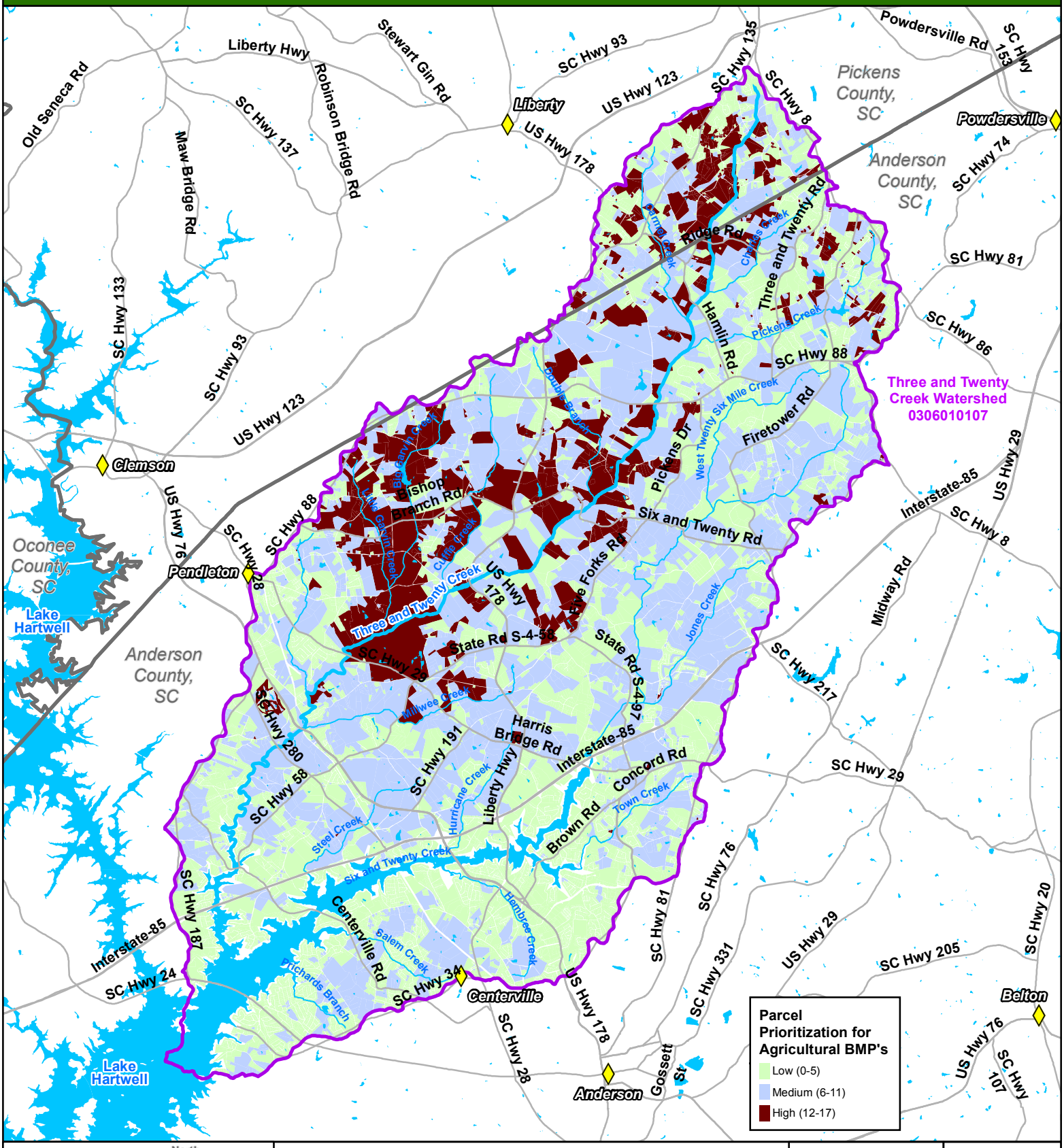

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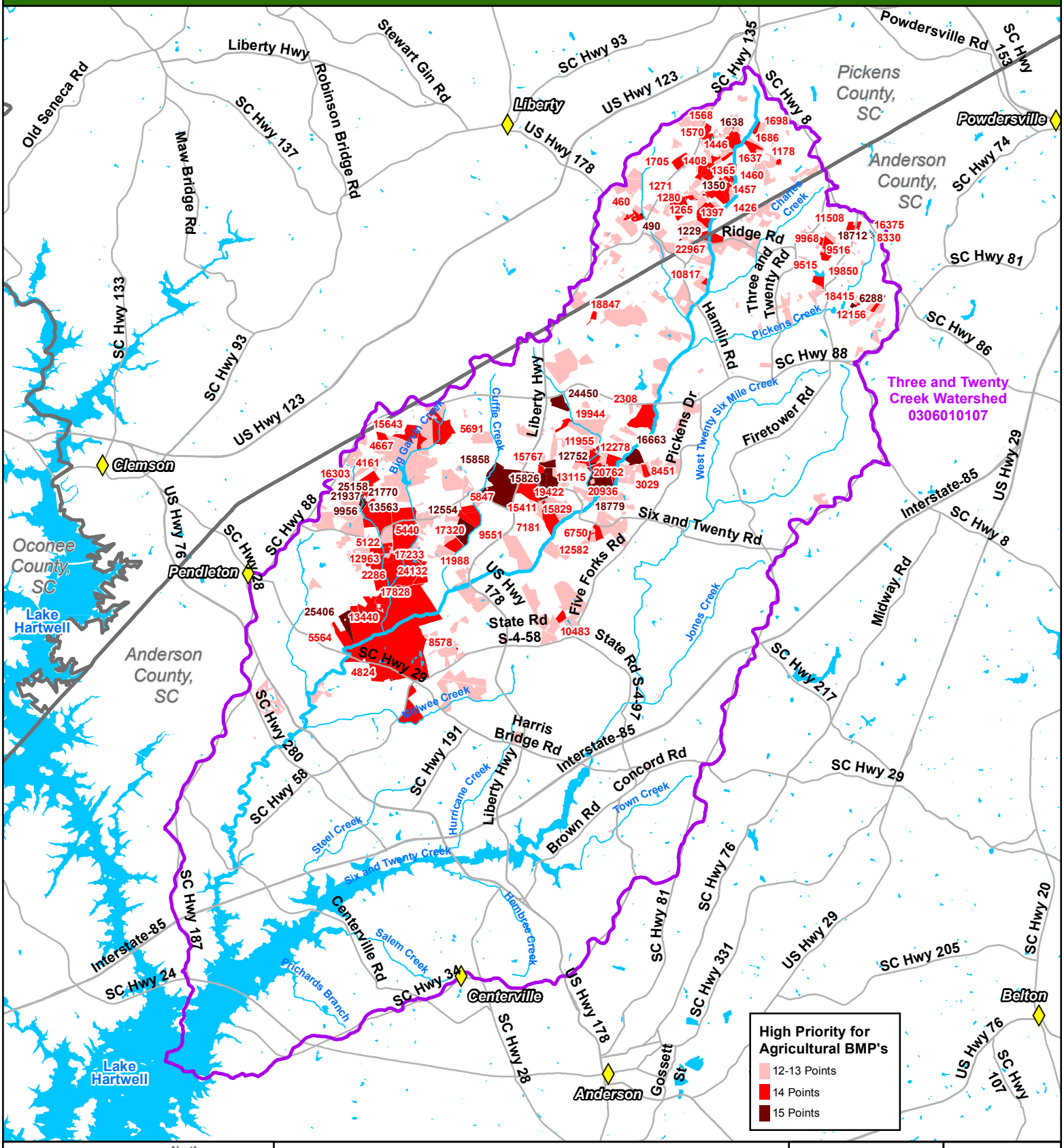
Figure 19: High Priority Parcels for Agricultural BMP's



Legend

- Cities/Towns
- Roads
- HUC-10: 0306010107 (Three and Twenty)
- County Line
- Lakes
- Streams
- Rivers/Creeks

0 0.75 1.5 3 4.5 6 Miles

N

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Table 37: HIGH PRIORITY PARCELS FOR AGRICULTURAL BMP'S

MapID	Acreage	TaxPin	County	State	PropertyLocation	Neighborhood	Ag_Score	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	Acres100	WetProt	ACEP	Wetland
15858	438.064	1140007008	Anderson	SC	7205 LIBERTY HWY		15	x	x	x	x	x	x				x	x		
12554	91.5634	880005024	Anderson	SC	512 LINK RD		15	x	x	x	x	x						x		
18779	139.688	1140005007	Anderson	SC	715 MELTON RD		15	x	x	x		x					x			
15826	70.4796	1140008003	Anderson	SC			15		x	x		x								
16663	59.3608	1400002036	Anderson	SC			15		x	x										
25406	58.304	630002006	Anderson	SC	115 SCOTT CIR		15		x	x		x								
24450	51.6057	1130006054	Anderson	SC			15		x	x		x								
21770	7.35262	610002047	Anderson	SC			15		x	x		x								
6288	6.03364	1900012001	Anderson	SC	621 LAKE RD		15		x	x										
13563	4.62836	610002045	Anderson	SC	3031 REFUGE RD		15		x	x		x								
9956	3.5811	610002042	Anderson	SC	3051 REFUGE RD		15		x	x		x								
12752	3.34107	1140006029	Anderson	SC			15		x	x		x								
21937	1.83324	610002048	Anderson	SC	3061 REFUGE RD		15		x	x										
1229	1.08698	5016-00-06-7555	Pickens	SC	103 BLACK RD	FINLEY FARMS	15		x	x		x								
25158	0.875753	610003013	Anderson	SC	501 MULLIKEN RD		15		x	x										
1350	0.720993	5017-00-31-3570	Pickens	SC	1033 ZION SCHOOL RD	STONE MEADOW	15		x	x										
1638	0.6141	5017-07-68-3490	Pickens	SC	447 ZION SCHOOL RD		15		x	x		x								
18712	0.582598	1890606005	Anderson	SC	WYATT OAKS 1512 OLD MILL RD		15		x	x										
490	2.88206	5006-02-69-5249	Pickens	SC	175 DENMARK DR		15			x		x								
17828	358.328	620004029	Anderson	SC	1514 CHERRY ST EXT		14	x	x	x	x	x					x	x		
5440	168.079	610005005	Anderson	SC	533 BISHOPS BRANCH RD		14	x	x	x	x	x					x	x		
5691	142.174	870002004	Anderson	SC			14	x	x	x	x	x	x				x	x		
2308	140.21	1400002001	Anderson	SC	113 GRIFFITH DR		14	x	x	x	x	x					x	x		
1397	65.4471	5017-00-41-7684	Pickens	SC	959 ZION SCHOOL RD		14	x	x	x	x							x		
1266	65.2919	5016-00-39-7695	Pickens	SC	1195 ZION SCHOOL RD		14	x	x	x	x							x		

Parcels sorted by Agricultural Score, highest to lowest. This table includes only the top 25 parcels.

13) WETLAND RESTORATION/ENHANCEMENT

This analysis identifies parcels containing impacted, low quality, or inundated wetlands that could provide additional water quality and quantity benefits if restored or enhanced to a higher quality wetland. Wetlands provide many natural ecosystem services such as water filtration, acting as pollutant sinks, wildlife habitat, erosion control, and flood management. Wetlands that have been impacted or inundated are likely no longer providing the myriad of important ecological and water quality benefits that are possible. Restoring impacted, low quality, and inundated wetlands is ecologically beneficial and can reduce the costs of water treatment, flood management, and pollution control by providing those services naturally.

13.1) Wetland Restoration/Enhancement Criteria

Table 38 is an overview of the specific criteria and possible points that were used to evaluate each parcel. Each parcel's total score was used to determine those that are of high (12-18 points), medium (6-11 points), and low (0-5 points) priority for wetland restoration/enhancement (see Figure 20). These ranges were chosen based on the total available points and the highest scores parcels achieved from this analysis. For a detailed overview of the criteria and scoring, please refer to Appendix F.

Table 38. Criteria and Ranking System for Wetland Restoration/Enhancement

Criteria	Ranking	Points	Total Possible Points per Category
Restorable Wetlands (prerequisite for further analysis)	Wetlands with Special Modifiers (excavated, spoil, artificial substrate, diked/impounded, managed, farmed, partially drained/ditched, beaver)	2	4
	Historic Wetlands	2	
Current Water Quality Impairments	Includes, Adjacent to, or Upstream of Existing Impairments	3	3
Current Pollutant Export (for each Nitrogen, Phosphorus, and Sediment)	High Range of Export	3	9 (3 point maximum for each pollutant)
	Medium Range of Export	2	
Water Impoundments and Dams	Low, Medium, and High Hazard Dams	2	2
TOTAL POSSIBLE WETLAND POINTS PER PARCEL			**18**

13.2) Wetland Restoration/Enhancement Results and Recommendations

Sixty-six parcels fell within the high priority range, with the highest achieved score of 14 and concentrated along the Big and Little Garvin Creeks (Figure 21). It is recommended to coordinate with developers in need of wetlands mitigation credit to provide funding to restore many of these wetland areas.

Left: Constructed Wetland
Right: Before and After Wetland Restoration Project
(source: CEEweb for Biodiversity)

Figure 20: Parcel Prioritization for Wetland Restoration/Enhancement

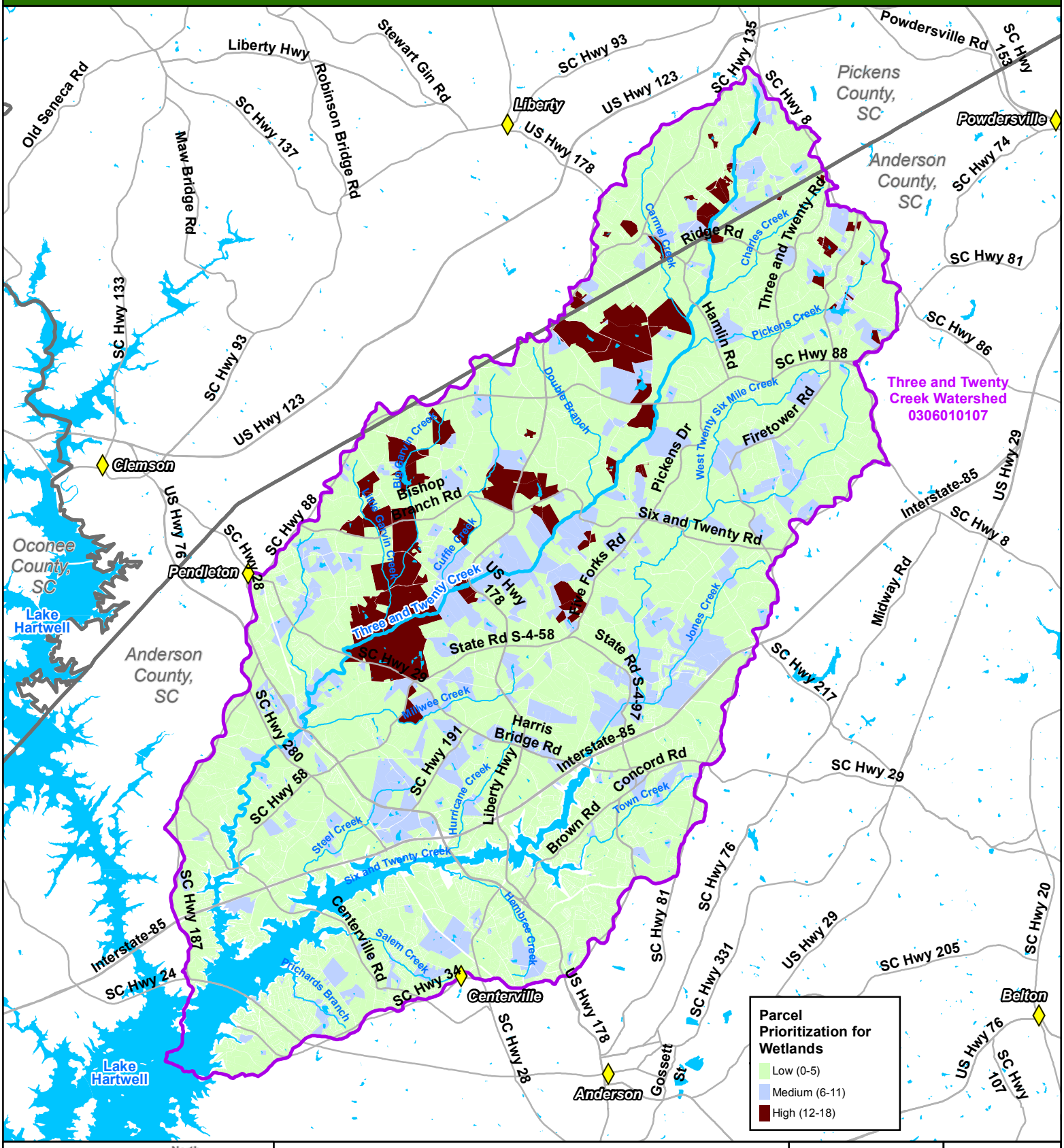

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Figure 21: High Priority Parcels for Wetland Restoration/Enhancement

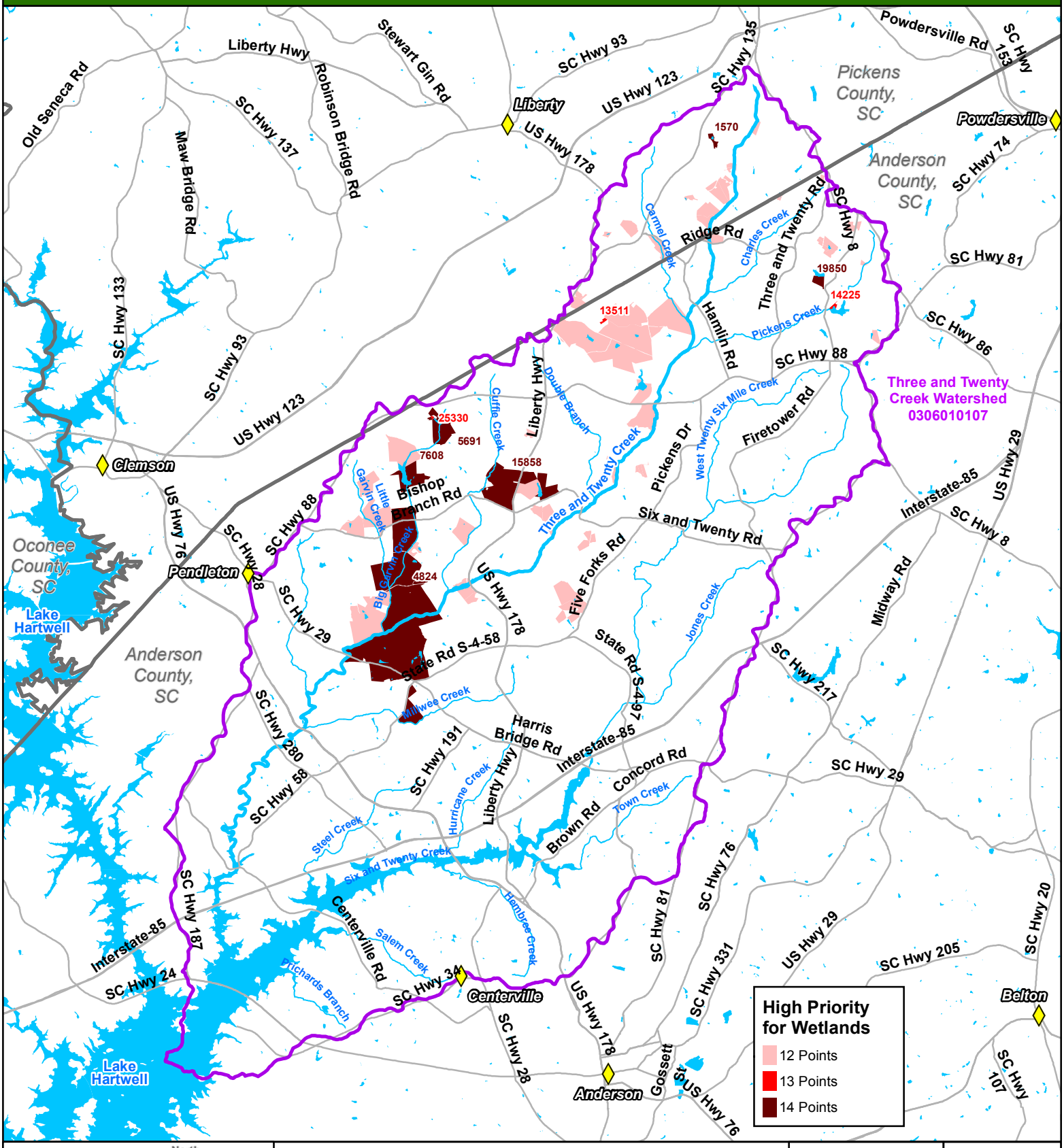

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Table 39: HIGH PRIORITY PARCELS FOR WETLAND RESTORATION/ENHANCEMENT

MapID	Acreage	TaxPin	County	State	PropertyLocation	Neighborhood	Wetland_Score	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	Acres100	WetProt	ACEP	Wetland
15858	438.064	1140007008	Anderson	SC	7205 LIBERTY HWY		14	x	x	x	x	x	x				x	x		x
5691	142.174	870002004	Anderson	SC			14	x	x	x	x	x	x				x	x		x
7608	141.434	870006026	Anderson	SC			14	x	x	x	x	x	x				x	x		x
4824	2120.3	890004001	Anderson	SC			14		x	x	x	x					x			x
19850	28.7011	1630007006	Anderson	SC	104 FIRE STATION RD		14		x	x	x	x	x							x
1570	17.1156	5017-06-47-1695	Pickens	SC	229 MT CALVARY CHURCH RD		14		x	x	x									x
13511	5.28596	1120001008	Anderson	SC	140 CHARLIE RD		13		x	x	x	x								x
25330	2.0192	870002022	Anderson	SC	406 GILLESPIE RD		13			x	x									x
14225	6.59369	1900013028	Anderson	SC	1100 ROBINSON RD		13		x		x	x	x							x
17828	358.328	620004029	Anderson	SC	1514 CHERRY ST EXT		12	x	x	x	x	x					x	x		x
4324	210.799	870006001	Anderson	SC			12	x	x	x	x	x					x	x		x
2299	195.528	1380001018	Anderson	SC	1020 SLAB BRIDGE RD		12	x	x	x	x	x					x	x		x
5440	168.079	610005005	Anderson	SC	533 BISHOPS BRANCH RD		12	x	x	x	x	x					x	x		x
6606	157.411	1160002008	Anderson	SC	205 JERRY DALRYMPLE DR		12	x	x	x	x	x					x	x		x
2308	140.21	1400002001	Anderson	SC	113 GRIFFITH DR		12	x	x	x	x	x					x	x		x
12554	91.5634	880005024	Anderson	SC	512 LINK RD		12	x	x	x	x	x						x		x
18293	65.4794	890004036	Anderson	SC	6415 LIBERTY HWY		12	x	x	x	x	x						x		x
1397	65.4471	5017-00-41-7684	Pickens	SC	959 ZION SCHOOL RD		12	x	x	x	x							x		x
1266	65.2919	5016-00-39-7695	Pickens	SC	1195 ZION SCHOOL RD		12	x	x	x	x							x		x
20936	54.5426	1140006007	Anderson	SC	646 MELTON RD		12	x	x	x	x	x						x		x
1426	44.7043	5017-00-52-5654	Pickens	SC			12	x	x	x	x							x		x
511	43.0936	5006-02-85-3948	Pickens	SC			12	x	x	x	x							x		x
1265	42.315	5016-00-38-5653	Pickens	SC			12	x	x	x	x							x		x
15411	88.9807	1150002010	Anderson	SC	7200 LIBERTY HWY		12		x	x	x	x								x
11331	87.1834	610005010	Anderson	SC	601 BISHOPS BRANCH RD		12		x	x	x	x								x

Parcels sorted by Wetland Score, highest to lowest. This table includes only the top 25 parcels.

14) RIPARIAN BUFFER RESTORATION/ENHANCEMENT

This analysis identifies parcels that are high priority for riparian buffer restoration/enhancements with the end goal of improving current riparian buffer areas, increasing vegetation coverage, and adding riparian buffers to sensitive areas. SCDNR recommends establishment and maintenance of a riparian buffer as the single most important BMP for the protection of stream and river resources. Riparian buffers provide many ecological benefits such as erosion and nonpoint source pollution control and filtration, wildlife habitat, streambank stabilization, and groundwater recharge. While the necessary width of a buffer to provide such ecosystem services depends on a number of factors, wider riparian buffers provide more benefits (Pennsylvania Land Trust Association, n.d.) . Increasing the coverage of riparian buffers, especially along impaired or sensitive streams, can reduce the cost of water treatment, help mitigate future impairments, and assist with erosion and flood control. For the protection of water quality, a minimum buffer width of 40 to 80 feet, bordering each side of the stream or lake is recommended, and is dependent on slope (SCDNR, 2008). For the protection of wildlife habitat and scenic value, the SC Scenic Rivers Program, managed by SCDNR, strongly advocates a minimum buffer of 100 feet bordering each side of water bodies.

14.1) Riparian Buffer Restoration/Enhancement Criteria

Table 40 is an overview of the specific criteria and possible points that were used to evaluate each parcel. Each parcel's total score was used to determine those that are of high (18-26 points), medium (9-17 points), and low (0-8 points) priority for riparian buffer restoration/enhancement (see Figure 22). For a detailed overview of the criteria and scoring, please refer to Appendix F.

Table 40. Criteria and Ranking System for Riparian Buffer Restoration/Enhancement

Category	Criteria	Points	Total Possible Points per Category
Highly Sensitive Riparian Buffer Areas (prerequisite for further analysis)	Within/adjacent to the highly sensitive riparian buffer areas layer	4	4
Stream Order	First and Second Order Streams	4	4
Adjacency to Drinking Water Reservoirs or Intakes	Adjacent to Drinking Water Reservoirs or Intakes	4	4
	Adjacent to Waterways	2	
Current Water Quality Impairments	Include, Adjacent to, or Upstream of Existing Impairments	3	3
Current Pollutant Export (for each Nitrogen, Phosphorus, and Sediment)	High Range of Export	3	9 (3-point maximum for each pollutant)
	Medium Range of Export	2	
100-Year Floodplain	Within/adjacent to 100-year floodplain	2	2
TOTAL POSSIBLE BUFFER POINTS PER PARCEL			**26**

14.2) Riparian Buffer Restoration/Enhancement Results and Recommendations

This analysis identified 579 parcels as high priority for riparian buffer restoration/enhancement. To further refine high priority results, parcels within urban floodplain areas were removed; these parcels will likely be covered under Stormwater BMPs (see Section 15). Of the remaining 537 high priority parcels, 18 scored a total of 21 points out of a possible 26 and are highly concentrated in the Lower and Upper Three and Twenty Creek Watersheds (0306010107-02/03), specifically, north of SC-29, as well as the northernmost portion of the Upper Six and Twenty Creek Watershed (030601010703). UF recommends focusing the riparian buffer strategies listed below in the watershed.

14.3) Riparian Buffer Restoration/Enhancement Strategies

The following are recommendations for riparian buffer restoration and/or enhancement strategies for the Three and Twenty Creek Watershed.

14.3.1) Ensure Compliance with Lake Hartwell's Shoreline Management Plan

As detailed in section 16.2, the U.S Army Corps of Engineers, which owns and manages Lake Hartwell, developed the *Shoreline Management Plan for Hartwell Lake Project; Georgia and South Carolina* in 2007. This Shoreline Management Plan is thorough and outlines specific use requirements, referring to shoreline as "all public land located between private property and the 660 MSL (mean sea level) line" (U.S Army Corps of Engineers, 2007). UF recommends maintaining natural vegetation within this buffer zone, utilizing plants included on the approved plant list (Exhibit III of the Shoreline Management Plan). See Section 16.2 for additional information and recommendations. Additionally, a source water protection area width of 1,500 buffer feet has been designated for the utility to provide extra protection to these important drinking water sources. The protection area includes sections of Six and Twenty Creek, Jones Creek, Hurricane Creek, Deep Creek arm of Lake Hartwell (Figure 4).

14.3.2) City/County Riparian Buffer Ordinances

The most cost-effective way to ensure long-term health of riparian buffers is to work with local governments to adopt land use regulations to establish required riparian buffer zones and to limit activities allowed within riparian buffers. Local governments should develop buffer management plans to coordinate efforts between utilities, industries, and private and commercial landowners within the watershed. Successful plans would consider the implementation of appropriate recommendations of various state and federal agencies on riparian buffer management.

A statewide task force on Riparian Buffers, convened in 2000 at the University of South Carolina (USC), agreed on a recommended minimum buffer width of 35 feet of native vegetation on each side to protect water quality (USC, 2000). UF recommends developing buffer management plans to include the implementation of buffer widths that meet or exceed the minimum width of 35 feet, restoration programs, considerations of current and future land use, and public eduation. While the city of Clemson and Anderson County have included riparian buffer protections in their 2014 and 2016 Comprehensive Planning processes, respectively, they lack mandates to address implementation and enforcement of their recommendations.

A city ordinance is an effective approach to addressing protections for waterways and riparian areas. Possible outcomes include preventing clear-cutting to a waterway's edge, protecting the

natural canopy, improving stormwater management in highly urban areas, and providing long-term water quality protection. The EPA has provided technical guidance and examples of successful aquatic buffer ordiances throughout the US (U.S EPA, 2019). The guidance states that effective buffer ordinances provide guidelines for buffer creation and maintenance, and should require:

1) buffer boundaries to be clearly marked on local planning maps
2) language that restricts disturbance of vegetation and soil
3) tables that illustrate buffer width adjustment by slope and type of waterway, and
4) direction on allowable uses and public education.

A recent study showed a significant loss in riparian buffers from the years 2001 – 2011 along the main stem of the Reedy River (Greenville County, 2017). Spurred by these findings and the well understood water quality benefits provided by buffers, Greenville County staff drafted a buffer ordinance, currently proposed as a 100-foot total buffer zone for streams with drainage areas <50 acres, and a 200-foot total buffer zone for streams with drainage areas >50 acres. A buffer ordinance developed for Anderson County or Pickens County could similarly provide the ecological and economic benefits outlined in this section.

14.3.3) Restoration/Enhancement

Land adjacent to waterways, lakes, ponds, and wetlands can be restored to their natural vegetated state by stabilizing banks, planting native vegetation with appropriate density, and ensuring proper maintenance. Potential partners for restoration projects could include developers in need of stream or wetland mitigation in the area, and landowners looking to protect or improve their property.

Example of a Healthy Riparian Buffer Restoration
(source: Creekside project, city of Austin, TX)

14.3.4) Tree Giveaways

Voluntary participation programs such as tree giveaways are an efficient public education and community involvement tool that can also benefit water quality. Programs like this can be targeted to specific areas, like the Three and Twenty Creek Watershed, and can be used to encourage landowners to plant trees near streams/shorelines, which will in turn provide water quality and riparian buffer benefits (e.g., streambank stabilization, additional shade/vegetative cover, and erosion control).

Tree Giveaways (source: Trees Greenville; Keys Energy Services)

Figure 22: Parcel Prioritization for Riparian Buffer Restoration/Enhancement

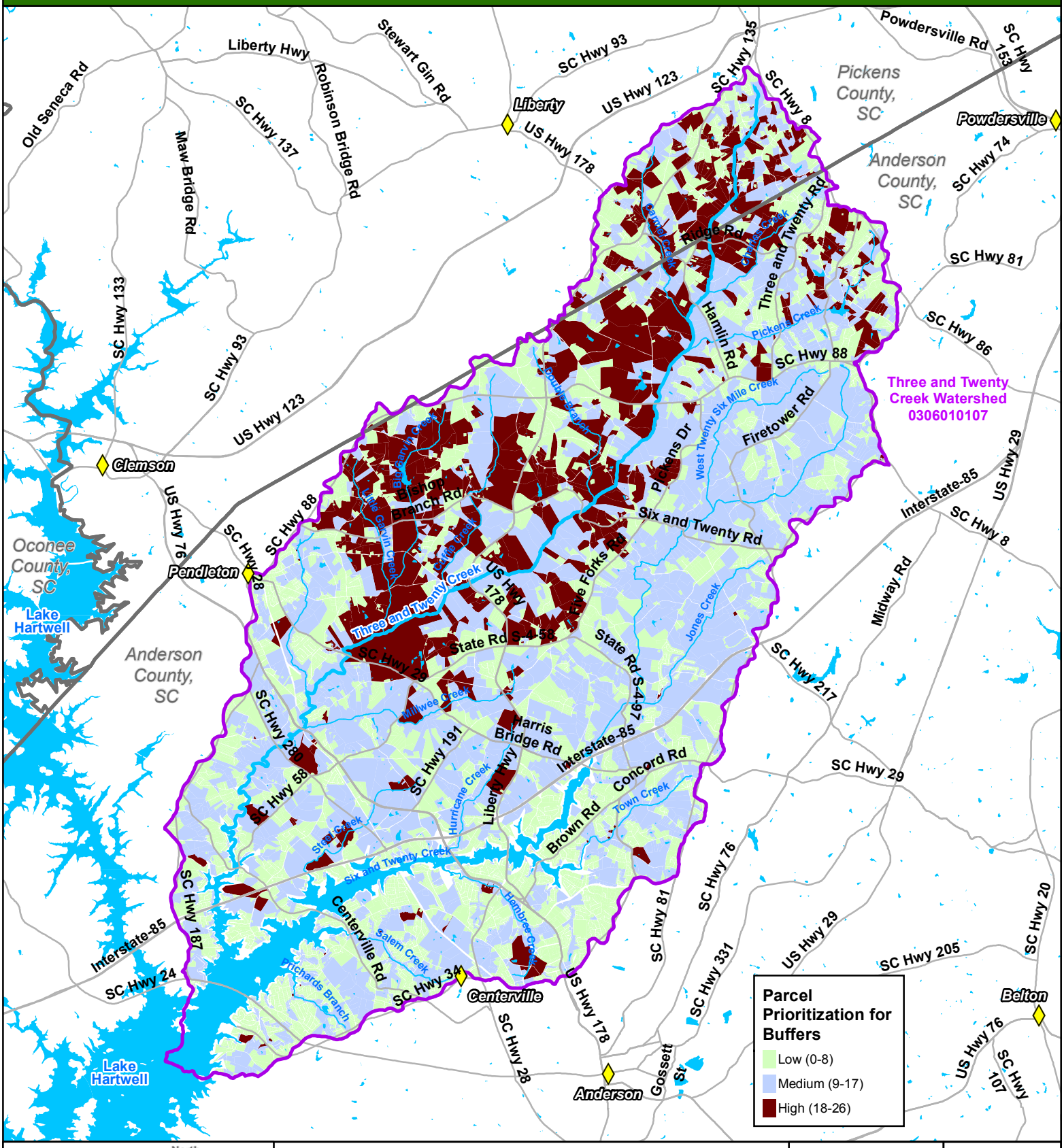

Figure 23: High Priority Parcels for Riparian Buffer Restoration/Enhancement

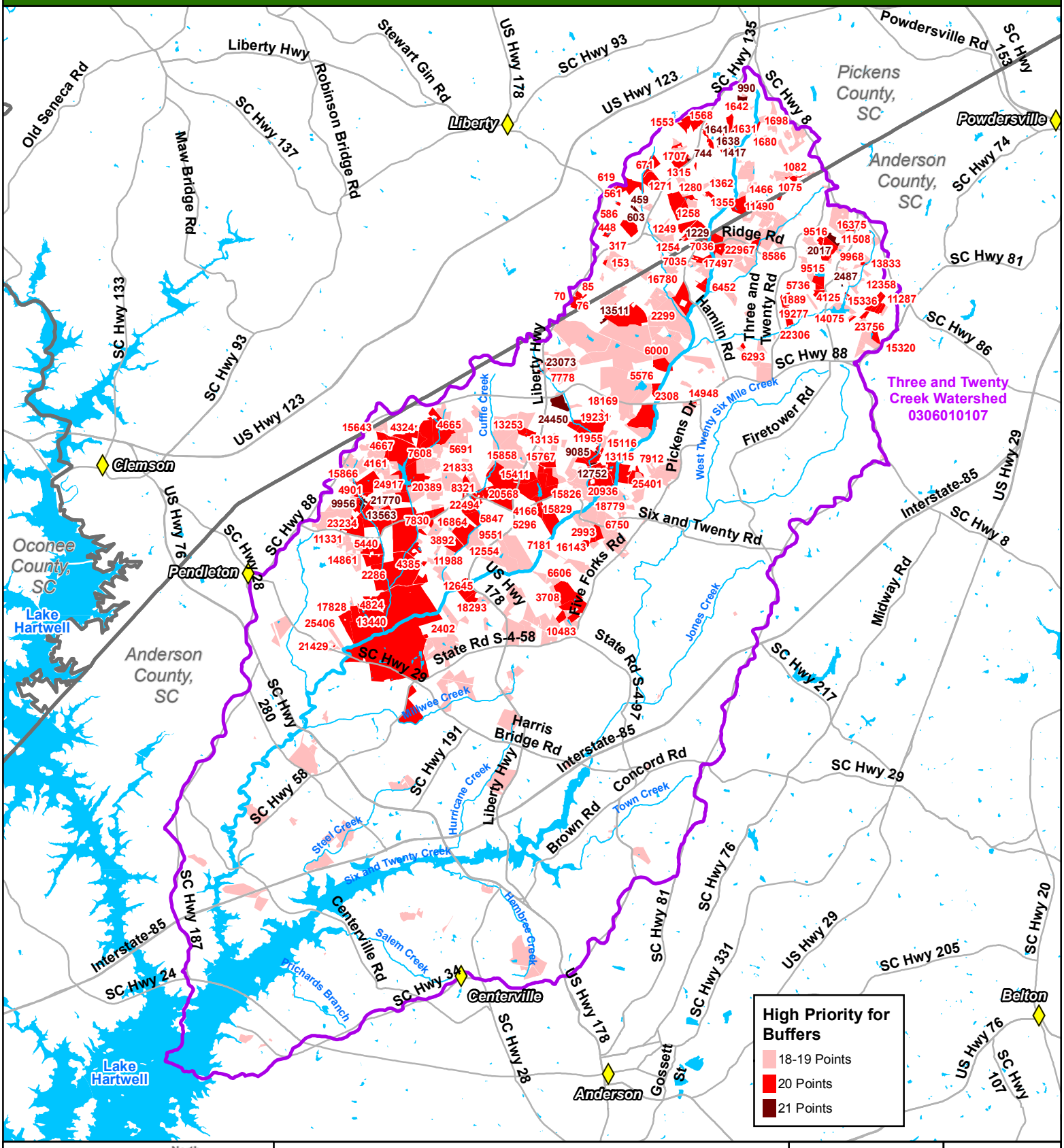

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Table 41: HIGH PRIORITY PARCELS FOR RIPARIAN BUFFER RESTORATION/ENHANCEMENT

MapID	Acreage	TaxPin	County	State	PropertyLocation	Neighborhood	Buffer_Score	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	Acres100	WetProt	ACEP	Wetland
13511	5.2859602	1120001008	Anderson	SC	140 CHARLIE RD		21		x	x	x	x								x
24450	51.6057014	1130006054	Anderson	SC			21		x	x		x								
2017	22.2033997	1890001022	Anderson	SC			21		x	x		x								
990	12.8722	5018-19-71-4936	Pickens	SC	120 MISSION DR		21		x	x		x								
1641	8.0382996	5017-07-68-9621	Pickens	SC	429 ZION SCHOOL RD		21		x	x		x								
21770	7.3526201	610002047	Anderson	SC			21		x	x		x								
459	6.3451099	5006-02-59-8851	Pickens	SC	177 DENMARK DR		21		x	x		x								
13563	4.6283598	610002045	Anderson	SC	3031 REFUGE RD		21		x	x		x								
9956	3.5811	610002042	Anderson	SC	3051 REFUGE RD		21		x	x		x								
12752	3.3410699	1140006029	Anderson	SC			21		x	x		x								
744	2.9531701	5017-09-15-6259	Pickens	SC	1720 ANDERSON HWY		21		x	x		x								
9085	1.93664	1140006023	Anderson	SC			21		x	x		x								
1229	1.08698	5016-00-06-7555	Pickens	SC	103 BLACK RD	FINLEY FARMS	21		x	x		x								
2487	0.976535	1890801013	Anderson	SC	WESTON ESTS 900 LAKE RD		21		x	x		x								
1638	0.6141	5017-07-68-3490	Pickens	SC	447 ZION SCHOOL RD		21		x	x		x								
23073	4.13094	1130002012	Anderson	SC	8213 LIBERTY HWY		21		x			x			x					
603	1.51709	5007-00-50-4155	Pickens	SC	184 DENMARK DR		21		x			x			x					
1417	0.574044	5017-00-46-8845	Pickens	SC			21		x			x								
15858	438.0639954	1140007008	Anderson	SC	7205 LIBERTY HWY		20	x	x	x	x	x	x				x	x		x
17828	358.3280029	620004029	Anderson	SC	1514 CHERRY ST EXT		20	x	x	x	x	x					x	x		
4324	210.798996	870006001	Anderson	SC			20	x	x	x	x	x					x	x		
2299	195.5279999	1380001018	Anderson	SC	1020 SLAB BRIDGE RD		20	x	x	x	x	x					x	x		
5440	168.0789948	610005005	Anderson	SC	533 BISHOPS BRANCH RD		20	x	x	x	x	x					x	x		
6606	157.4109955	1160002008	Anderson	SC	205 JERRY DALRYMPLE DR		20	x	x	x	x	x					x	x		
5691	142.173996	870002004	Anderson	SC			20	x	x	x	x	x	x				x	x		x

Parcels sorted by Buffer Score, highest to lowest. This table includes only the top 25 parcels.

15) VOLUNTARY DAM REMOVAL

This analysis identifies parcels containing dams that may be suitable for voluntary removal, at the property owner's discretion and approval if the owner is no longer receiving enough benefits to outweigh the liability and maintenance responsibilities. Voluntary dam removals would prevent the possibility of future dam breaches and would restore natural flows to rivers and streams.

15.1) Voluntary Dam Removal Criteria

Table 42 is an overview of the specific criteria and possible points that were used to evaluate each parcel. Each parcel's total score was used to determine those that are of high (5 points), medium (2 points), and low (0 points) priority for dam removal (see Figure 24). For a detailed overview of the criteria and scoring, please refer to Appendix F.

Table 42. Criteria and Ranking System for Voluntary Dam Removal

Category	Criteria	Points	Total Possible Points per Category
Water Impoundments and Dams (prerequisite for further analysis)	Low, Medium, and High Hazard Dams	2	2
Current Water Quality Impairments	Includes, Adjacent to, or Upstream of Existing Impairments	3	3
TOTAL POSSIBLE VOLUNTARY DAM REMOVAL POINTS			**5**

15.2) Voluntary Dam Removal Results, Recommendations and Funding Sources

This analysis identified 17 parcels as high priority for exploring if the landowner would be interested in a voluntary dam removal. To identify parcels containing dams with higher probability of successful removal, parcels meeting the following qualifications were selected for further analysis:

1. Agricultural land use
2. Dams on small ponds (impounding less than 50 acres of water)
3. Parcels were REMOVED if: Dam located in large subdivisions, gated communities, or with obvious recreational usage

The refined results identified 9 parcels (see Table 44: High Priority Parcels for Dam Removal) we recommend for further evaluation for potential voluntary dam removal (see Figure 25), given landowner approval. Most of these dams are located on farms, residential properties, or undeveloped lands. If a dam on agricultural land is providing water to livestock, we recommend coordinating EQIP or Section 319 funding to fence cattle out of streams and install an alternate water source to improve water quality. Dams that could be identified as providing an amenity within neighborhoods or golf courses (at the mapping scale) were removed, but a field analysis should be conducted to further evaluate remaining dams. The high priority parcels are mostly located within the upper portion of the Three and Twenty Creek Watershed.

Figure 24: Parcel Prioritization for Voluntary Dam Removal

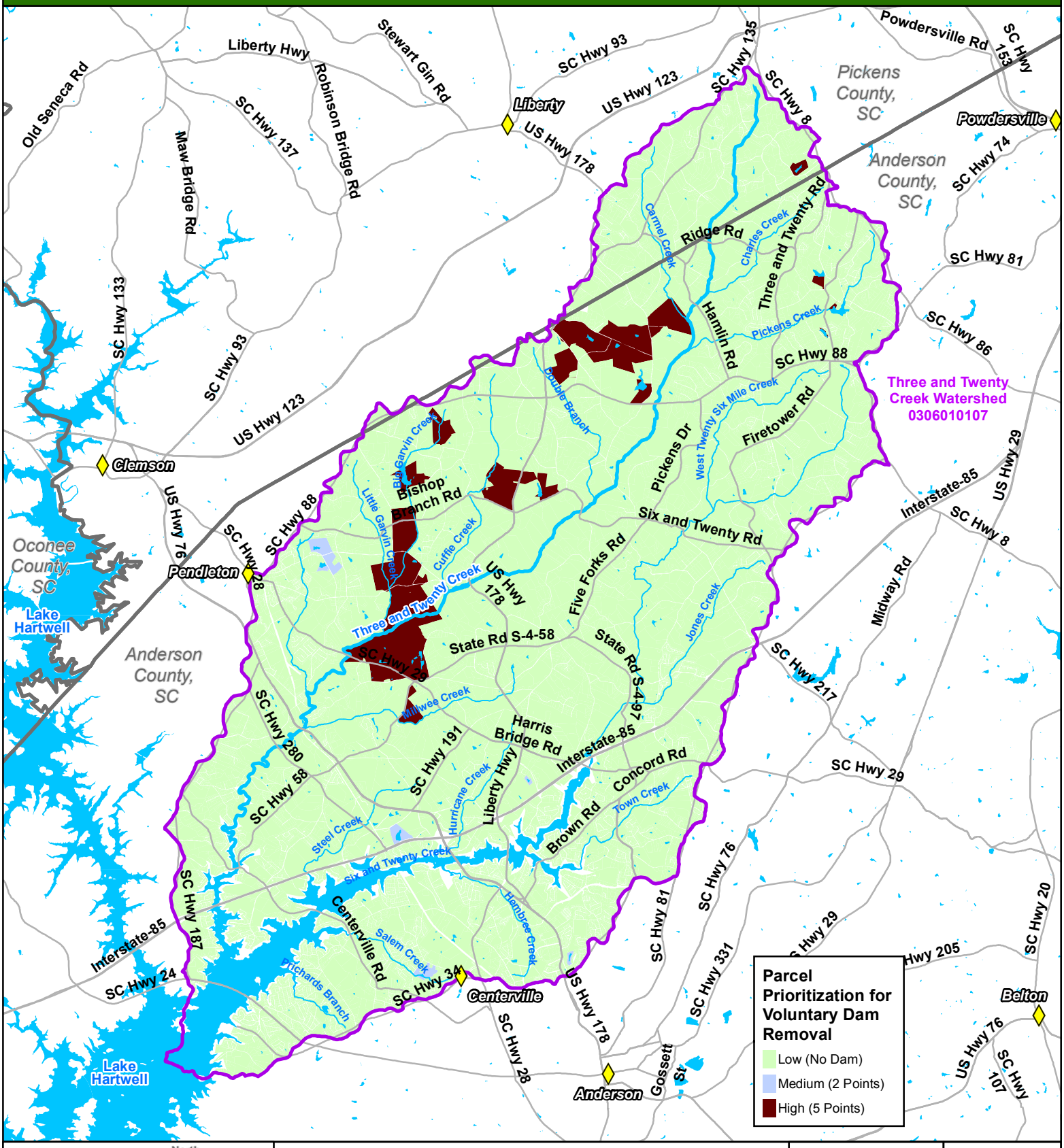

Figure 25: High Priority Parcels for Voluntary Dam Removal

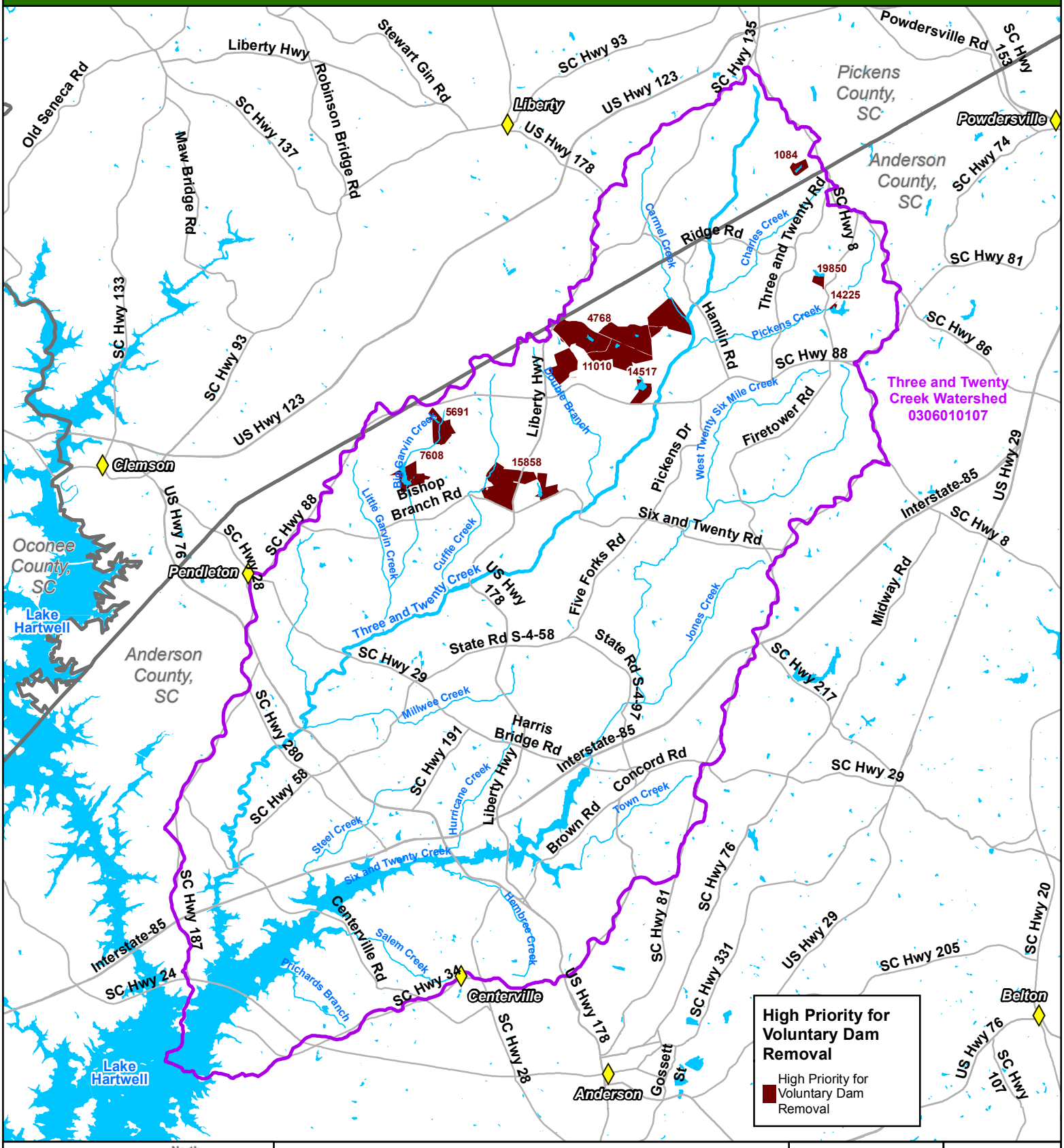

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Table 43: HIGH PRIORITY PARCELS FOR VOLUNTARY DAM REMOVAL

MapID	Acreage	TaxPin	County	State	PropertyLocation	Dam_Score	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	Acres100	WetProt	ACEP	Wetland
15858	438.0639954	1140007008	Anderson	SC	7205 LIBERTY HWY	5	x	x	x	x	x	x				x	x		x
5691	142.173996	870002004	Anderson	SC		5	x	x	x	x	x	x				x	x		x
7608	141.4340057	870006026	Anderson	SC		5	x	x	x	x	x	x				x	x		x
19850	28.7010994	1630007006	Anderson	SC	104 FIRE STATION RD	5		x	x	x	x	x							x
4768	1122.77002	1120002003	Anderson	SC	1420 RED BARN RD	5	x	x		x	x	x				x	x		x
14517	82.0523987	1390001003	Anderson	SC		5	x	x		x	x	x					x		x
14225	6.5936899	1900013028	Anderson	SC	1100 ROBINSON RD	5		x		x	x	x							x
11010	166.0780029	1130003012	Anderson	SC		5		x	x		x	x				x			
1084	49.3111992	5027-00-34-7453	Pickens	SC	312 JOHNSON RD	5		x				x							

Parcels sorted by Dam Score, highest to lowest. This table includes all high priority parcels for Voluntary Dam Removal.

16) SHORELINE MANAGEMENT

This analysis identifies parcels adjacent to drinking water reservoirs or intakes that are high priority for Shoreline Management BMPs with the end goal of reducing pollutants directly entering drinking water sources. Properties adjoining drinking water reservoirs directly impact water quality just before the intake, with little opportunity for settling or filtration. Proper management of these properties can help to ensure the safety of the drinking water supply. Managed properly, shoreline parcels have the ability to slow stormwater runoff, protect against streambank erosion, filter pollutants, and help control flooding. Because many drinking water sources are used recreationally and are surrounded by private landowners, encouraging certain management strategies can help to reduce the cost of water treatment and prevent pollutants from directly entering a drinking water reservoir before an intake facility.

16.1) Shoreline Management Criteria

Table 44 is an overview of the specific criteria and possible points used to evaluate each parcel. Each parcel's total score was used to determine those that are of high (14-20 points), medium (7-13 points), and low (0-6 points) priority for Shoreline Management (see Figure 26). For a detailed overview of the criteria and scoring, please refer to Appendix F.

Table 44. Criteria and Ranking System for Shoreline Management

Category	Criteria	Points	Total Possible Points per Category
Adjacency to Drinking Water Reservoirs or Intakes (prerequisite for further analysis)	Adjacent to Drinking Water Reservoirs or Intakes	4	4
Current Pollutant Export (for each Nitrogen, Phosphorus, and Sediment)	High Range of Export	3	9 (3-point maximum for each pollutant)
	Medium Range of Export	2	
Highly Sensitive Riparian Buffer Areas	Within/adjacent to the highly sensitive riparian buffer areas layer	4	4
Private Boat Ramps or Docks	Private Boat Ramps	2	3
	Private Docks	1	
TOTAL POSSIBLE SHORELINE MANAGEMENT POINTS			**20**

16.2) Shoreline Management Results and Recommendations

This analysis identified 145 high priority parcels along Lake Hartwell (see Figure 26 and Table 46). No further refinement was conducted since shoreline management is specific to each reservoir.

16.2.1) Ensure Compliance with Lake Hartwell's Shoreline Management Plan

In 2007, the U.S Army Corps of Engineers, which owns and manages Lake Hartwell, developed the *Shoreline Management Plan for Hartwell Lake Project; Georgia and South Carolina* with

the goal of properly managing Lake Hartwell for "optimum recreational experiences…while assuring compatibility among permitted private uses, general public use, and protection of project resources" (U.S Army Corps of Engineers, 2007). This Shoreline Management Plan (SMP) is thorough and outlines specific use requirements, as further detailed in Sections 16.2.2-16.2.4. UF recommends ensuring compliance with the requirements detailed in the SMP.

16.2.2) Restore Lawns along Shorelines

Maintaining/improving natural riparian vegetation along the shorelines of drinking water reservoirs is important. UF encourages maintaining natural buffers along shorelines by encouraging landowners not to mow lawns down to the shoreline and to maintain natural vegetation. The U.S Army Corps of Engineers' Shoreline Management Plan refers to shoreline as "all public land located between private property and the 660 MSL (mean sea level) line" (U.S Army Corps of Engineers, 2007). UF recommends maintaining natural vegetation within this buffer zone, using plants included on the approved plant list (Exhibit III of the Shoreline Management Plan). New plantings on public land must be approved by the U.S Army Corps of Engineers' Operations Project Manager prior to planting.

Lakefront Property with Vegetated Buffer vs. Eroded Shoreline
(source: Upstream Waters Landscape; Clemson University)

16.2.3) Private Boat Ramp Removal

Private boat ramps impact water quality while providing benefits to a limited number of people. Removing these ramps would reduce stormwater runoff impacts and, if replaced with a vegetated buffer, would provide water quality improvements. Landowners with unused or unmaintained boat ramps may be most amenable to their removal. UF recommends working with the U.S Army Corps of Engineers to ensure existing private boat ramp compliance/maintenance and working to incentivize older boat ramp removals or boat ramp improvements. According to the Shoreline Management Plan, construction of new private boat ramps, roads, and turnarounds has been prohibited for many years.

16.2.4) Private Boat Dock Maintenance

UF recommends that water utilities work with the U.S Army Corps of Engineers and shoreline landowners to ensure that private boat docks are well-maintained, free from contaminants, and in compliance with riparian buffer, encroachment, and land use requirements as outlined in the Shoreline Management Plan.

16.2.5) Data Collection

UF recommends that water utilities collect information on shoreline land uses that will provide information such as presence of docks or ramps and current status of shoreline management. Collecting data on shoreline landowners and their shoreline activities would allow for the identification of poor or improper shoreline management, which could then be reported to the U.S Army Corps of Engineers for improvements.

Figure 26: Parcel Prioritization for Shoreline Management

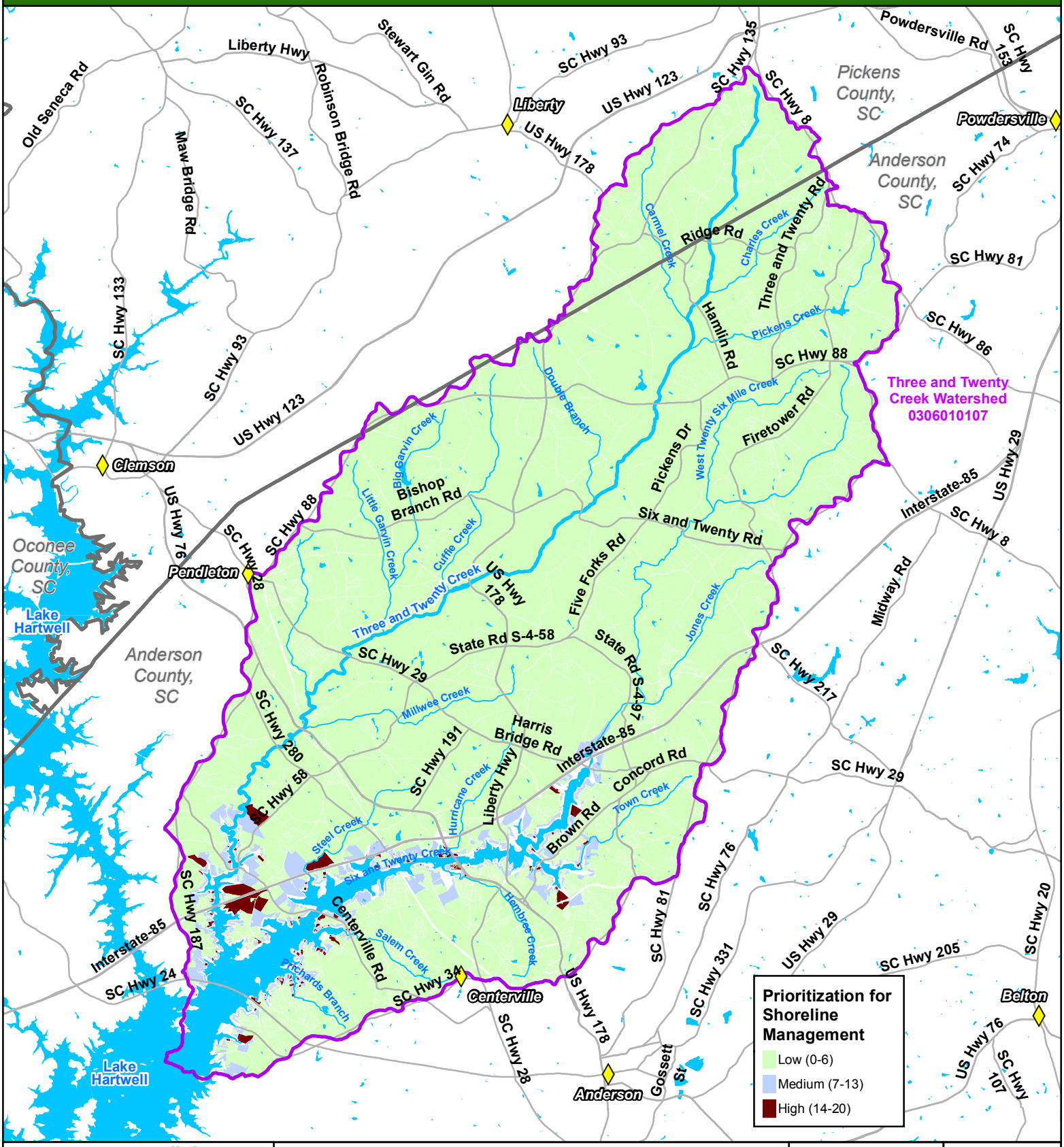

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Figure 27: High Priority Parcels for Shoreline Management

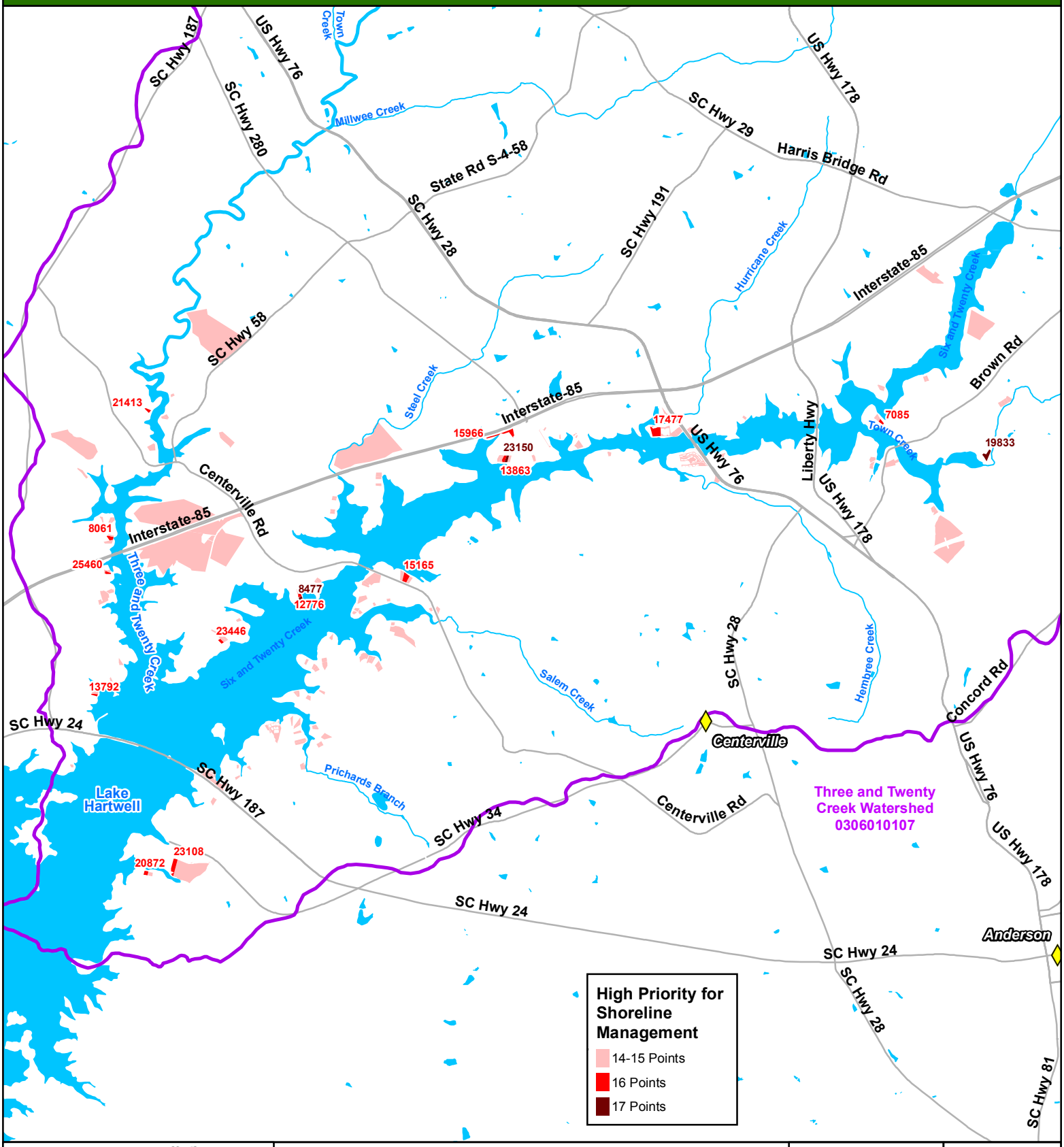

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Table 45: HIGH PRIORITY PARCELS FOR SHORELINE MANAGEMENT

MapID	Acreage	TaxPin	County	State	PropertyLocation	Shore_Score	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	Acres100	WetProt	ACEP	Wetland
19833	1.85377	1200005006	Anderson	SC	1501 MCCLELLAN RD	17		x					x						
23150	0.780986	660901038	Anderson	SC	1012 NORTH SHORE DR	17		x					x						
8477	0.382238	670101025	Anderson	SC	235 POINTS END	17		x					x						
23108	2.75736	470303006	Anderson	SC		16		x					x						
15165	2.07427	670601012	Anderson	SC	SURFSIDE HGTS 2218 SURFSIDE DR	16		x					x						
8061	0.976364	450501027	Anderson	SC	LEISURE VILLAGE 1128 CARTEE RD	16		x					x						
13863	0.909384	660901039	Anderson	SC	NORTH SHORE 1010 N SHORE DR	16		x					x						
20872	0.788423	470201003	Anderson	SC	HUNTINGTON HGTS 326 HUNTINGTON RD	16		x					x						
23446	0.604558	450701031	Anderson	SC	131 MAFFETT CIR	16		x					x						
7085	0.588768	1200901021	Anderson	SC	GREEN HILL PLANTAT304 STEPHEN KING DR	16		x					x						
25460	0.576113	450401008	Anderson	SC	ISLAND FORD 1215 WILLIAMS RD	16		x					x						
12776	0.483771	670101026	Anderson	SC	231 POINTS END	16		x					x						
17477	3.76806	930302001	Anderson	SC	1025 GEORGE SMITH MILL RD	16							x						
15966	2.4270501	660901055	Anderson	SC	NORTH SHORE 2019 POMPANO DR	16							x						
21413	0.57922	441801042	Anderson	SC	CENTERVILLE SHORES205 SHORE DR	16							x						
13792	0.518007	460003019	Anderson	SC	317 WHAM RD	16							x						
3006	122.4830017	450004007	Anderson	SC	1021 ASBURY RD	15		x			x		x			x			
11732	74.0859985	440002008	Anderson	SC	711 SANDY SPRINGS RD	15		x			x		x						
15120	67.6504974	660011013	Anderson	SC		15		x			x		x						
7154	27.9104004	440008019	Anderson	SC	5601 HIX RD	15		x			x		x						
22113	23.2381992	470007001	Anderson	SC		15		x			x		x						
20322	8.9934702	671002001	Anderson	SC		15		x					x						
8256	5.5428801	670501001	Anderson	SC	125 DIAMOND PT	15		x					x						
8706	3.09238	1200301003	Anderson	SC	TOWN CREEK ACRES 500 BROWN RD	15		x					x						
18150	1.78447	680803035	Anderson	SC	PRITCHARD CREEK 401 GRAHAM RD	15		x					x						

Parcels sorted by Shoreline Score, highest to lowest. This table includes only the top 25 parcels.

17) STORMWATER BMPS

This analysis identifies parcels within developed areas that may be appropriate for installation of stormwater retrofits, which would reduce stormwater runoff and pollutant loading into nearby waterways. Urbanized areas, particularly those built prior to stormwater management requirements, are at an increased risk of negatively impacting nearby waterways from the high density of impervious surfaces. Impacts, such as increased surface water runoff, decreased groundwater recharge, stream channelization, and heightened erosion and flooded areas can all attribute to impaired water quality and can be mitigated by the installation of stormwater BMPs.

17.1) Stormwater BMPs Criteria

Table 46 is an overview of the specific criteria and possible points that were used to evaluate each parcel. Each parcel's total score was used to determine those that are of high (12-16 points), medium (6-11 points), and low (0-5 points) importance for Stormwater BMPs (see Figure 28). For a detailed overview of the criteria and scoring, please refer to Appendix F.

Table 46. Criteria and Ranking System for Stormwater BMPs

Category	Criteria	Points	Total Possible Points per Category
Land Cover (prerequisite for further analysis)	Urban/Developed Land	2	2
	Known Logging Operations	1	
Current Pollutant Export (for each Nitrogen, Phosphorus, and Sediment)	High Range of Export	3	9 (3-point maximum for each pollutant)
	Medium Range of Export	2	
Current Water Quality Impairments	Includes, Adjacent to, or Upstream of Existing Impairments	3	3
Unpermitted Point Source Pollutants	Unpermitted Point Source Pollutants (see Section 15.1.4)	1	1
Permitted Point Source Pollutants	Permitted Point Source Pollutants (see Section 15.1.5)	1	1
TOTAL POSSIBLE STORMWATER BMP POINTS			**16**

17.2) Stormwater BMPs Results, Recommendations, and Potential Funding Sources

This analysis identified 671 parcels as high priority for installation of stormwater BMPs. To further refine high priority results, parcels meeting the following qualifications were selected for more in-depth analysis:

1. Parcels outside of MS4 Designations, as these are less likely to have stormwater regulations and more likely benefit more highly from stormwater retrofits or installation
2. Parcels were REMOVED if: have agricultural land cover that is likely covered under agricultural BMP considerations

The refined results identified 168 parcels (see Figure 29 and Table 47: High Priority Parcels for Stormwater BMPs) for further analysis. Concentrations of parcels can be seen in the upper half of the Three and Twenty Creek Watershed. Out of 16 points, only three parcels scored a total of 14 points, two of which are in close proximity to Little Garvin Creek. Upstate Forever recommends further analyzing the high priority parcels to determine which would have the highest impact in regards to stormwater management. Additionally, working with counties to strengthen stormwater regulations outside of MS4's will help to ensure proper stormwater management, especially in areas of high development.

General stormwater education and outreach efforts could have significant benefits to local communities. Stormwater education and outreach is required as part of the MS4 Permit. A partnership with the Pickens and Anderson County Soil and Water Conservation Districts, which is responsible for carrying out stormwater education in Pickens and Anderson County, could help effectively conduct stormwater outreach in the watershed. Additionally, engaging with the Anderson and Pickens County Stormwater Partners (APCSP) group would assist with outreach and education efforts. Together these agencies carry out stormwater outreach education throughout Anderson and Pickens Counties. These groups will be instrumental in carrying out the stormwater education component of this plan in the watershed.

17.2.1) Section 319 Funding (SCDHEC)

The U.S EPA provides annual funding to SCDHEC for projects that reduce or prevent nonpoint source water pollution by implementing an approved Watershed-Based Plan. SCDHEC distributes these Section 319 funds through grants that may pay up to 60 percent of eligible project costs, with a 40 percent non-federal match. Projects both within and outside of MS4 boundaries are eligible, however it is recommended to contact SCDHEC in advance to confirm eligibility.

17.3) Stormwater BMPs Strategies

17.3.1) Stormwater BMPs

In areas built prior to stormwater control requirements, installation of detention/retention ponds, pervious pavement, rain gardens, or rain barrels could provide significant reduction of stormwater runoff and pollutants. Focusing on publicly owned parcels (e.g., schools, parks) or parcels upstream from known flooding problems may provide streamlined implementation.

Examples of Constructed Rain Garden, Detention Pond, and Pervious Pavement

17.3.2) Stormwater BMP Retrofits

In areas built prior to stormwater water quality requirements, existing detention ponds could be retrofitted to provide pollutant removal. Again, focusing on publicly owned parcels (e.g., schools, parks) may provide streamlined implementation.

Figure 28: Parcel Prioritization for Stormwater BMP's

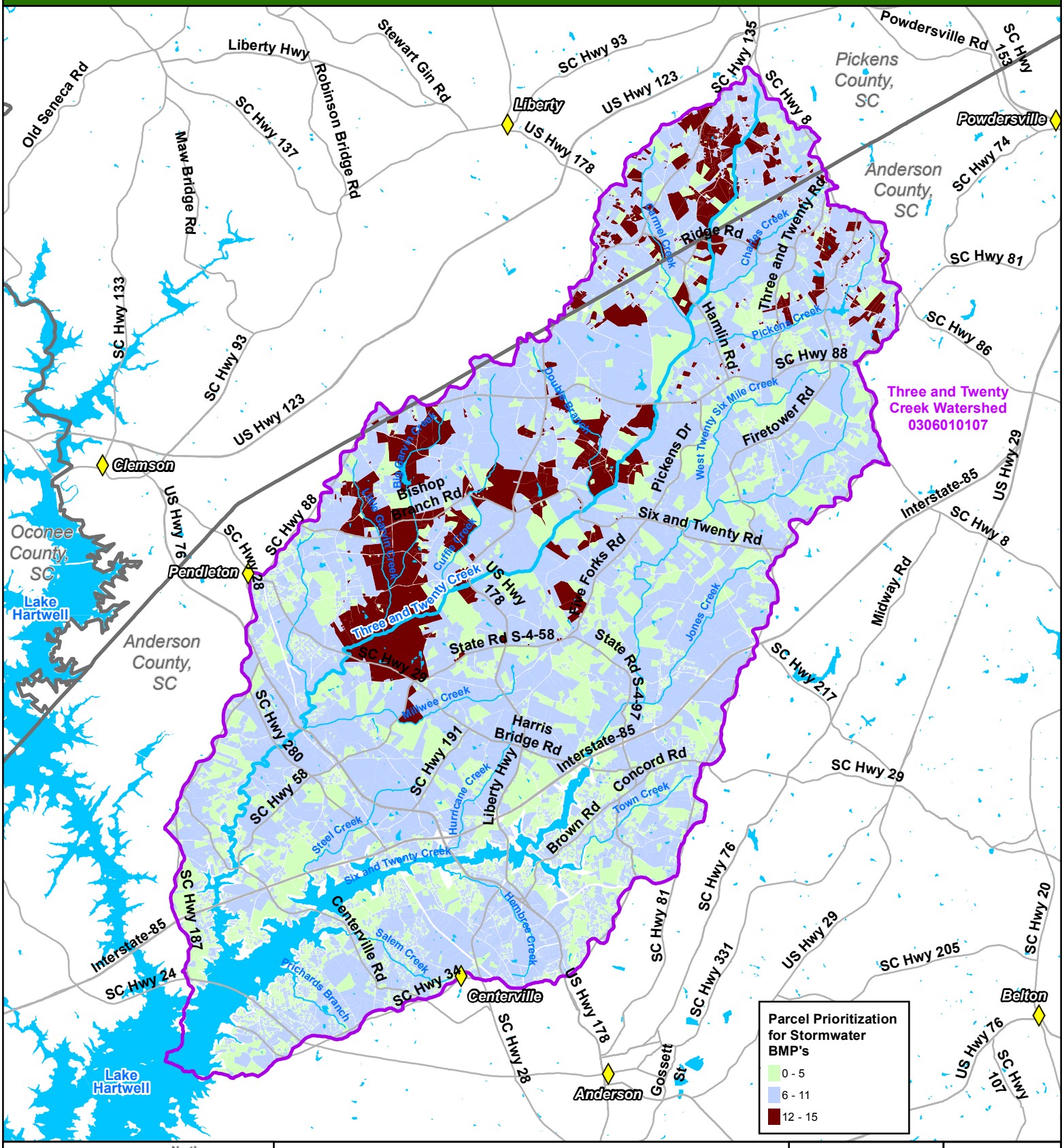


Figure 29: High Priority Parcels for Stormwater BMP's

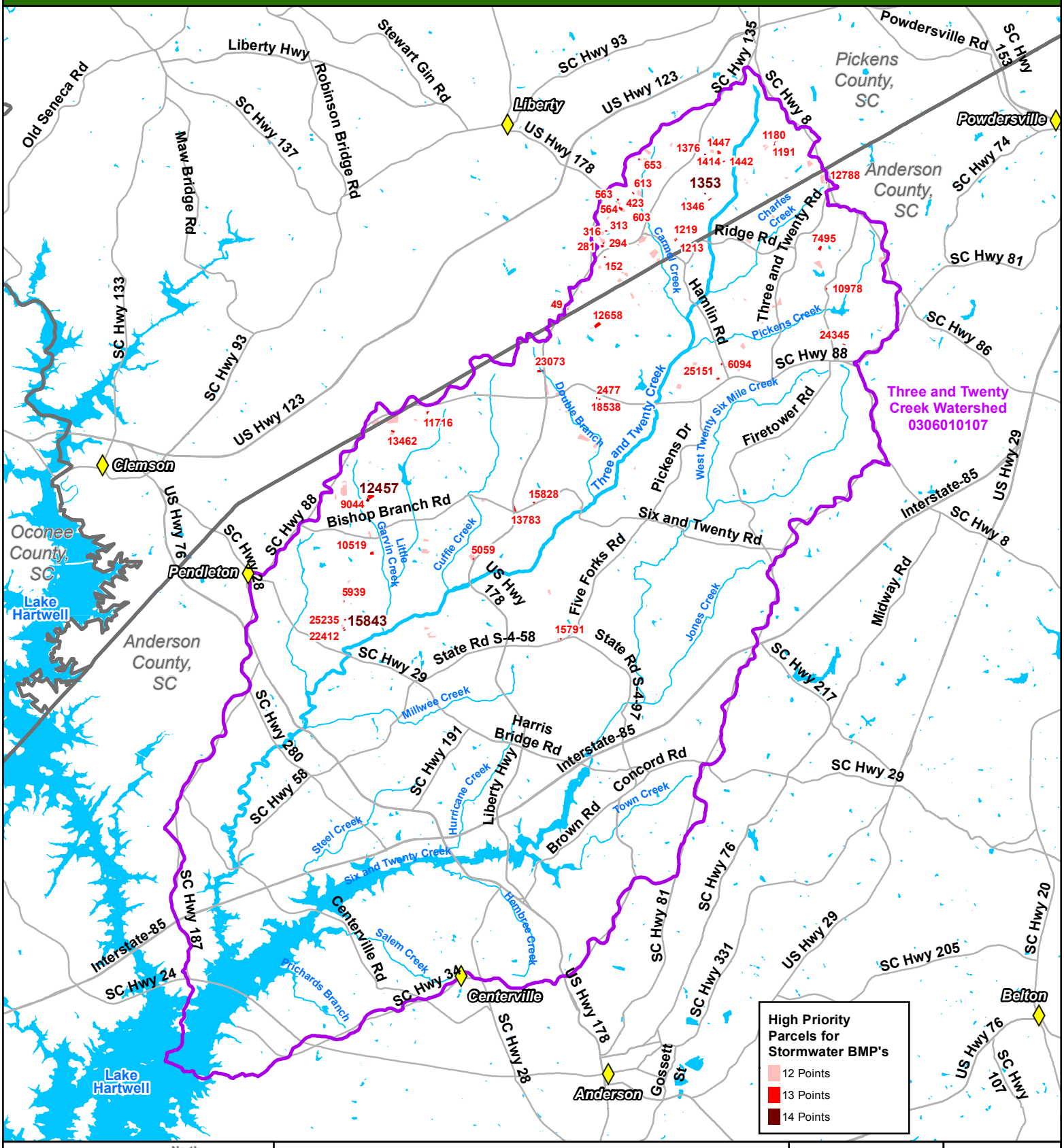


Table 47: HIGH PRIORITY PARCELS FOR STORMWATER BMP'S

MapID	Acreage	TaxPin	County	State	PropertyLocation	Neighborhood	Storm_Score	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	Acres100	WetProt	ACEP	Wetland
12457	2.49874	610002029	Anderson	SC	3101 REFUGE RD		14								x					
15843	0.698564	630102016	Anderson	SC	245 SCOTT CIR		14								x					
1353	0.589384	5017-00-31-4549	Pickens	SC	1027 ZION SCHOOL RD	STONE MEADOW	14								x					
23073	4.13094	1130002012	Anderson	SC	8213 LIBERTY HWY		13		x			x			x					
603	1.51709	5007-00-50-4155	Pickens	SC	184 DENMARK DR		13		x			x			x					
9044	7.3555102	610003001	Anderson	SC	3211+3223+3225 REFUGE RD		13								x					
12658	6.1438198	1120001012	Anderson	SC			13								x					
13783	3.66766	1150002002	Anderson	SC	7106 LIBERTY HWY		13								x					
7495	3.07985	1630007034	Anderson	SC	323 HUNT RD		13								x					
423	2.97403	5006-01-49-2970	Pickens	SC	270 FLAT ROCK RD		13								x					
10519	2.6329999	620002010	Anderson	SC	1635 DANENHOWER RD		13								x					
281	1.97509	5006-01-25-1897	Pickens	SC	150 FLAT ROCK CHURCH RD		13								x					
13462	1.92182	600003011	Anderson	SC	146 HOWE RD		13								x					
1447	1.81642	5017-00-56-0065	Pickens	SC	700 ZION SCHOOL RD		13								x					
11716	1.48554	860008002	Anderson	SC	407 GILLESPIE RD		13								x					
15828	1.3324	1150002007	Anderson	SC	2301 SIX + TWENTY RD		13								x					
10978	1.25933	1630006005	Anderson	SC			13								x					
1414	1.23392	5017-00-46-8175	Pickens	SC	248 MT CALVARY CHURCH RD		13								x					
1346	1.15563	5017-00-30-9966	Pickens	SC	151 LIZ LN		13								x					
25151	1.12924	1390102006	Anderson	SC	SHADOW HILL 113 SHADOW HILLS LN		13								x					
613	1.09622	5007-00-51-6606	Pickens	SC	237 WATTS RD		13								x					
6094	1.05813	1650002008	Anderson	SC	GREENVILLE COUNTRY207 MOORE RD		13								x					
15791	0.993672	1170002036	Anderson	SC			13								x					
294	0.957849	5006-01-26-3176	Pickens	SC	113 STARLIGHT LN		13								x					
25235	0.922871	630002009	Anderson	SC	115 SCOTT CIR		13								x					

Parcels sorted by Stormwater Score, highest to lowest. This table includes only the top 25 parcels.

18) PET WASTE STATIONS

This analysis identifies parcels that may be suitable for the installation of a pet waste station to encourage proper disposal of pet waste and reduce bacteria loadings from pets. Domestic pet waste is a threat to human health and water quality when not disposed of properly. Pet waste - which can contain harmful organisms such as bacteria, viruses, and parasites - will be carried into, and pollute, nearby waterways during rain events. Based on the national averages for number of dog-owning homes, number of dogs per dog-owning household, and the approximate amount of waste each dog can produce annually, there are an estimated 9,426 dogs in the Three and Twenty Creek Watershed producing a total of 2.58 million pounds of waste each year (see Section 4.1.2). Public outreach campaigns on proper pet waste disposal will be helpful to reduce this bacterial loading in the watersheds.

18.1) Pet Waste Station Criteria

Table 48 is an overview of the specific criteria and possible points that were used to evaluate each parcel. Each parcel's total score was used to determine those of high (1-2 points) and low (0 points) priority for pet waste station installations (see Figure 30). No medium priority range was included for this analysis as most parcels scoring in this category will receive 1 point at most. For a detailed overview of the criteria and scoring, please refer to Appendix F.

Table 48. Criteria and Ranking System for Pet Waste Stations

Category	Criteria	Points	Total Possible Points per Category
High Traffic Commercial Pet Locations	Locations that are likely to have increased dog traffic (See Section 16.1.1)	1	1
Parks	Existing Public Land	1	1
TOTAL POSSIBLE PET WASTE POINTS			**2**

18.2) Pet Waste Station Results and Recommendations

Pet waste stations are a cost-effective way to educate people about an important threat to water quality and empower people to properly dispose of their pet's waste. The visibility of this outreach message at popular public locations will educate the general public about water quality and may lead to additional behavioral changes.

This analysis identified 12 parcels (see Table 50: High Priority Parcels for Pet Waste Station Installation) as high priority for installation of pet waste stations. These parcels include 6 parks, 4 veterinary facilities, and 2 pet groomers/boarding facilities (see Figure 30 and Appendix B).

Example of a Pet Waste Station

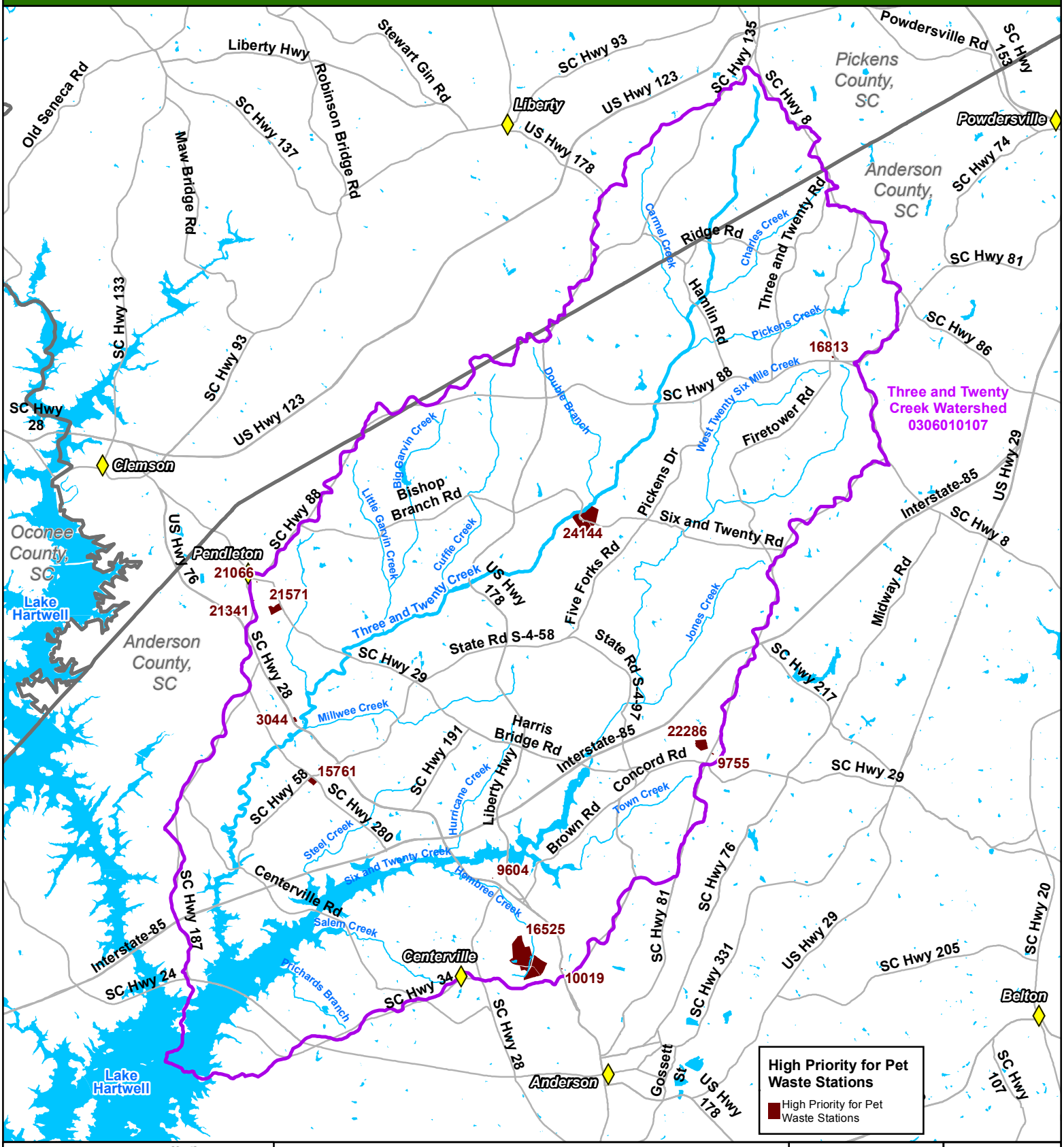
18.3) Pet Waste Station Unit Cost Estimates and Potential Funding Options

Cost estimates for urban BMPs are based on information provided by Greenville County and Anderson and Pickens County Stormwater Partners (APCSP). Table 50 outlines funding options and cost estimates for pet waste BMPs.

Table 49. Pet Waste Station Unit Costs and Potential Funding Sources

Nonpoint Sources of Bacteria Pollution	BMP	Estimated BMP Unit Cost	Potential Funding Sources
Domestic Pets	Pet Waste Station	$225 each ($300 for installation with bags)	• Anderson County SWCD • Pickens County SWCD • CU Extension • Anderson Pickens Stormwater Partners • Local Governments
	Pet Bags	$60/2,000	

Figure 30: High Priority Parcels for Pet Waste Station(s)



Legend

- Cities/Towns
- Roads
- HUC-10: 0306010107 (Three and Twenty)
- County Line
- Lakes
- Streams
- Rivers/Creeks

0 0.75 1.5 3 4.5 6 Miles

N

DISCLAIMER:

This map is not a land survey and is for general reference purposes only. Upstate Forever makes no warranty or representation as to the accuracy of this map and disclaims all responsibility for any costs or damages that may arise from its use.

MAP BY KPH 8/13/18

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Table 50: HIGH PRIORITY PARCELS FOR PET WASTE STATIONS

MapID	Acreage	TaxPin	County	State	PropertyLocation	Pet_Score	Protection	Septic	Ag	Wetlands	Buffers	Dams	Shoreline	Stormwater	PetWaste	Acres100	WetProt	ACEP	Wetland
24144	110.7809982	1150003004	Anderson	SC	2929 SIX + TWENTY RD	1	x	x			x				x	x			
16525	208.0310059	1220001001	Anderson	SC		1					x				x	x			
22286	29.6749992	1450003002	Anderson	SC		1									x				
21571	24.0839996	410003001	Anderson	SC	450 LEBANON RD	1									x				
15761	12.0860004	650011001	Anderson	SC		1									x				
3044	4.0482502	640301006	Anderson	SC		1									x				
16813	1.6375999	1910014002	Anderson	SC		1									x				
9755	0.967888	1450005004	Anderson	SC		1									x				
10019	0.648758	1221303011	Anderson	SC	2828 E NORTH AVE	1									x				
21341	0.59398	402001069	Anderson	SC	LIBERTY HALL VILLA	1									x				
21066	0.346656	401009006	Anderson	SC		1									x				
9604	0.291053	930901033	Anderson	SC	4325A OLD MILL RD	1									x				

Parcels sorted by Pet Score, highest to lowest. This table includes all high priority parcels for Pet Waste Stations.

19) WILDLIFE BMPS

Wildlife populations can contribute to elevated levels of bacteria and sediment in the focus area. However, it can be difficult to track their populations. Therefore, it is recommended that the identification of nuisance populations and target areas be included in the public outreach campaign. For example, educating landowners on the signs of nuisance wildlife activity, such as rooting damage by feral hogs, and asking them to help inventory locations of these wildlife populations can be completed simultaneously to improve efficiency. Once nuisance wildlife populations have been identified, the types and locations of BMPs can be prioritized accordingly.

19.1) Wildlife BMPs

There are a variety of BMPs which work to reduce the impacts of wildlife on water quality. The recommended BMPs focus on reducing erosion and the direct contribution of fecal matter into waterways. Examples can be found below.

19.1.1) Streambank Fencing

Streambank fencing can limit wildlife populations' access to streams, therefore protecting streams from both bacteria generated from waste as well as the damaging effects wildlife can have on landscapes, such as erosion. UF recommends focusing primarily on the high priority agricultural sites as detailed in Section 12.2.

Examples of Streambank Fencing

19.1.2) Riparian Buffers

Vegetated riparian barriers remove bacteria from runoff. Wild hogs tend to be attracted to heavily vegetated areas near streams, so effective management of a riparian buffer area would be necessary to ensure wildlife is not destructive to the buffers contributing to erosion. Buffers also discourage waterfowl (e.g., Canada geese) from congregating. Creating a buffer strip of tall thick vegetation will deter geese from using this shoreline as they typically prefer gently rolling slopes with short vegetation at the water's edge as it provides a clear line of vision to avoid predators and provide them easy access to the water (INDNR, 2017). UF recommends focusing on the high priority sites as identified in Section 14.2, as well as the Lake Hartwell shoreline as detailed in Section 16.2.


Riparian Buffer along Stream in Cleveland Park, Greenville, SC (left)
Geese along Mowed Portion of Riverbank in Falls Park, Greenville, SC (right)

19.1.3) Filter Strips

Filter strips, a "strip or area of vegetation for removing sediment, organic matter, and other pollutants from runoff and wastewater" can be used in combination with riparian areas to help maintain buffers, as well as to slow runoff, remove sediment and bacteria, increase soil aeration, and recycle plant nutrients (NRCS, 2018),. UF recommends focusing primarily on the high priority agricultural sites as detailed in Section 12.2.

Example of Riparian Buffer Filter Strips (source: GrainNews)

19.1.4) Trapping

Particularly effective with feral hog populations, trapping can assist with the management of populations through harvest, relocation, or consumption. Box, swing, and corral traps are all effective in the trapping of feral hogs. Trapping can also be effective with beaver populations. Wildlife Control Operators (WCO's) perform wildlife control services on a contract-fee basis and can be hired by landowners who do not wish to directly handle animals.

Example of Corral Trap for Wild Hogs

19.1.5) Hunting

Hunting is a common method used to control wildlife populations. Educating landowners and community members about the safety and training needed for this BMP method is important. Out of season permits for species such as deer and feral hogs can be obtained through SCDNR if the populations become problematic in the watershed (SCDNR, 2017).

19.1.6) No Feeding Wildlife Signage

Feeding wildlife often contributes to increases in nuisance species (e.g., deer, waterfowl) and can contribute to the increase of bacteria in waterways. One way to reduce wildlife populations in these areas is to discourage people from feeding wildlife, especially in public areas (e.g., parks).

No Feeding Wildlife Signage in Falls Park, Greenville, SC

19.2) Wildlife BMP Unit Cost Estimates and Funding Options

Some wildlife BMPs are also mentioned as possible agricultural solutions and can be used to control both wildlife and livestock populations. Because of this, some of the funding sources for wildlife BMPs are also mentioned in the agricultural BMP section. BMP unit cost estimates come from both the previously mentioned prices in the agricultural BMP section as well as estimates from NRCS. Table 51 provides an overview of wildlife BMP unit costs and possible sources of funding. The US Department of Agriculture, including the Natural Resources Conservation Service (NRCS) and Farm Service Agency (FSA), implements many voluntary programs that help reduce bacteria loading by establishing riparian buffers, protecting wetlands, and conserving water resources. Additional details are included below (Table 51).

Table 51. Wildlife BMP Unit Costs and Potential Funding Sources

Nonpoint Sources of Bacteria Pollution	BMP	Estimated BMP Unit Cost	Potential Funding Sources
• Feral Hogs • Beavers • Deer • Water Fowl • Coyote	Linear Streambank Fencing	$3.50/foot	• WHIP • EQIP • AWEP • CSP • County Governments • US Fish and Wildlife Service • Section 319 Funds
	Filter Strips	$168/acre	
	Riparian Buffers	$390/acre	
	Box, Swing, and Corral Traps	$320-460 each	Private Landowners

19.2.1) Section 319 Funding

The U.S EPA provides annual funding to SCDHEC for projects that reduce or prevent nonpoint source water pollution by implementing an approved Watershed-Based Plan. SCDHEC distributes these Section 319 funds through grants that will pay up to 60 percent of eligible project costs, with a 40 percent non-federal match generally provided by the landowner.

19.2.2) USDA NRCS

There are several voluntary NRCS programs that help reduce bacteria loading by establishing riparian buffers, protecting wetlands, and conserving water resources. Examples include WHIP, CSP, and EQIP. See Section 10.4 for more information on each of these federal cost share programs.

19.2.3) Community Participation

Community participation involves voluntary contributions, both monetary and in-kind, from watershed residents that can be used to meet match requirements for other grant funding source homeowners.

20) PUBLIC EDUCATION AND OUTREACH

A detailed public outreach strategy has been developed for the entire focus area that covers all nonpoint sources of bacteria, sediment, and nutrient impairments. This table can be found in Appendix G. Detailed information includes the target audience, messaging, outreach methods used, and recommended project partners are listed for each pollution source.

20.1) Mailings and Displays

Mailing lists will be compiled to facilitate communication with watershed residents regarding events, opportunities for potential projects, and general education. These lists can be used to send mailings that could include postcard invitations to meetings, workshops, information on conservation easements, agricultural and septic system BMP projects, and other nonpoint source pollution outreach events.

Including inserts with local utility providers' bills is also recommended to be utilized when possible. Because some utility providers mail water bills in postcard format, bill stuffers will not be feasible for all locations. However, placement of outreach materials (e.g., land protection, septic system maintenance, and agricultural BMP programs) at community gathering spots, such as city halls or community centers, is an alternative way to provide information to homeowners.

20.2) Community Meetings, Workshops, and Festivals

Community outreach meetings should be conducted as needed to discuss plan implementation, identify specific locations for BMP and land protection projects, and encourage landowner participation and engagement. Potential topics of discussion may include:

- Overview of watershed plan
- Watershed plan goals
- Priority land protection areas
- Priority agricultural BMP and septic system projects
- Priority Urban Stormwater projects
- Shoreline Management
- Possible funding sources for individual projects

Schools, community groups, and public library patrons would benefit from a variety of water quality educational publications and community workshops. Presentations to local landowners and community groups are an effective way to introduce groups to source water protection and nonpoint source pollution issues. Workshop topics could include conservation easements, agricultural BMPs, septic system maintenance and repair, pet waste, and nuisance wildlife. Storm drain stenciling and stream cleanups are excellent opportunities to engage the public, including youth organizations, while educating them about water quality issues. The schools listed in Table 54 include those from Anderson School Districts 1, 4, and 5 as these districts fall within the watershed (See Table 52). See Appendix H for an example of a flyer for a public outreach meeting hosted in conjunction with this Watershed-Based Plan's development.

Table 52. Community Groups, Municipalities, Libraries, and Schools for Public Outreach

Schools:	
• Calhoun Academy of the Arts • Concord Elementary School • McCants Middle School • Glenview Middle School • La France Elementary School • Midway Elementary School	• Mount Lebanon Elementary School • New Prospect Elementary School • Pendleton Elementary School • Pendleton High School • Riverside Middle School
Community Colleges and Universities:	
• Anderson University • Clemson University • Tri County Technical College	
Libraries:	
• Pendleton Branch • Clemson University Library	
Community Centers	
• Pendleton Community Center	
Scout Troops	
• Boy Scout Troop 215 – Anderson, SC • Boy Scout Troop 0096 – Catholic Church of St. Luke • Boy Scout Troop 0097 – Montessori School of Anderson • Cub Scout Pack 3997 – Montessori School of Anderson • Cub Scout Pack 3094 – Pendleton United Methodist Church • Cub Scout Pack 3227 – Flat Rock Baptist Church	

20.3) Additional Public Outreach and Education Efforts

Watershed residents who wish to learn more about the watershed-based plan will be able to find project updates as well as general water quality information online through stakeholder websites.

21) PROJECT IMPLEMENTATION, MILESTONES, AND MEASURABLE GOALS

The watershed-based plan implementation schedule will cover a span of 10 years with the intent of decreasing bacteria, sediment, and nutrients loads in the Three and Twenty Creek Watershed. The implementation strategy for this watershed plan will include the following stages: Project Identification, Implementation, Evaluation, and Refinement. Additionally, due to the size of the focus area and the number of high priority projects identified, the implementation plan is divided into three phases: Phase 1 (years 1-3); Phase 2 (years 4-6), and Phase 3 (years 7-10). Although total restoration of the focus area would be ideal, the plan focuses on incremental improvements in water quality over a 10-year time frame (see Tables 53-55).

21.1) Project Identification Period

The project identification phase involves contacting landowners that have been identified through the prioritization process for the various BMP strategies and discussing BMP strategies and funding options. Building relationships with these landowners is a crucial component in the success of BMP implementation. Communicating with landowners from the beginning will enable project managers to gauge interest in these projects early on in the process and increase the likelihood of success.

21.1.1) Land Protection

As with all voluntary landowner projects, the success of this work is dependent upon landowner participation. The first step will be to cultivate relationships with local landowners with the assistance of local utilities and organizations to gauge interest in land protection opportunities. Targeting those landowners identified as high priority parcels for land protection through the GIS parcel prioritization analysis is recommended. For those landowners not interested in conservation easements, it will be important to work with these individuals to identify if there are other, more appealing land protection strategies for their properties.

21.1.2) Restoration BMPs

Initial efforts will focus on building relationships with local landowners to identify specific agricultural BMP projects and secure funding for such projects. Partnerships with NRCS and local Soil and Water Conservation Districts (Anderson County SWCD and Pickens County SCWD) would facilitate project identification, design, and funding procurement. Because these agencies already have experience working with local landowners and farmers, as well as designing agricultural related water quality BMPs, their knowledge and involvement is essential to the success of this effort.

In regard to septic system repair and/or replacement, a public outreach campaign should be conducted in each region with the help of the local stormwater outreach agencies including Anderson Pickens County Stormwater Partners, Anderson County Stormwater, Pickens County Stormwater, and Clemson Extension, local utilities (ARJWS), as well as Anderson County SWCD to enroll homeowners in septic system replacement programs. Outreach methods will consist of general media advertisements, community meetings, bill stuffers, and displays at local government offices and public facilities (refer to Appendix C for more detailed information).

A public outreach campaign would be the most effective tool for riparian buffer restoration/enhancements, and could serve as a way to reach out to landowners identified as high priority through the GIS parcel prioritization analysis. Outreach will focus on proper shoreline management, such as not mowing down to waters' edges, targeted mailings, signage or brochures posted at public locations, and educational workshops in partnership with identified project partners.

Finally, working with identified project partners to complete supplemental BMPs and milestones as funding and resources allow will round out each phase with projects for shoreline management, wetland restoration, stormwater BMPs, and wildlife BMPs. Upstate Forever anticipates that public outreach will be the most cost effective way to implement goals under these BMP categories.

21.2) Project Implementation Period

Prior to project implementation it is extremely important that baseline water quality data is collected before and after projects are installed to measure changes in bacteria levels in relation to watershed improvements. Water quality monitoring should continue throughout the implementation period and should continue for up to a year after projects are installed. The final number of BMP projects installed will depend upon landowner participation and available funding sources.

21.3) Evaluation and Refinement Period

As it is difficult to predict landowner preferences and participation rates it will be necessary to periodically reassess project goals. Adjustments to the Public Outreach and Education Strategy may be needed if participation is lower than desired. It will also be important to evaluate the individual BMP projects themselves, making note of any problems that occurred before, during, and after construction to streamline the process for future participants. Consideration should also be given to new or revised stormwater management techniques as they become available.

To begin, relationships between project partners and landowners should be secured with general ideas of the BMPs or other implementation tasks desired by landowners, the funding opportunities specifically available for the desired implementation tasks, and the level of cooperation required to successfully achieve installment and proper management for continuous benefit. Therefore, an initial outreach-based plan should be introduced and implemented during the first two years.

Table 53. Project Milestones Phase 1: Years 1-3					
Action Items			**Years (1-3)**		
			1	**2**	**3**
Required BMPs to meet load reductions	*Land Protection*	Conduct outreach and education to priority landowners			
		Build relationships with landowners			
	Agricultural BMPs	Conduct outreach and education to landowners through cooperating agencies			
		Send out targeted mailings to high priority landowners			
		Complete 4 agricultural BMP projects			
	Septic BMPs	Conduct outreach to homeowners through targeted mailings, social media, local contractors, and public displays			
		Complete 20 septic repairs/replacements			
	Riparian Buffers	Work with local governments on strengthening riparian buffer ordinances			
	Pet Waste Stations	Install 3 pet waste stations			
Supplemental BMPs, as funding and resources allow	*Shoreline Management*	Coordinate with utility/lake owner to collect data on the current state of shoreline landowner properties			
	Wetland Restoration	Monitor development impacts to wetlands and recommend mitigation options			
	Stormwater BMPs	Review current stormwater regulations and recommend strengthened regulations outside of MS4 requirements			
		Work with project partners to identify stormwater hotspots and recommend future BMP projects			
	Wildlife BMPs	Pinpoint problem areas and collect cost information for identified best solutions			
	Send out surveys to participating landowners				
	Revise outreach and implementation strategies as needed				
	Complete quarterly updates on project website				
	Provide quarterly email and updates to stakeholders				

Table 54. Project Milestones Phase 2: Years 4-6					
Action Items			**Years (4-6)**		
			4	**5**	**6**
Required BMPs to meet load reductions	*Land Protection*	Conduct outreach and education to priority landowners; continue to build relationships			
		Facilitate the closing of 1-2 conservation easements (or 55+ acres) and/or other land protection strategies			
	Agricultural BMPs	Conduct outreach and education to landowners through cooperating agencies			
		Send out targeted mailings to high priority landowners			
		Complete 4 agricultural BMP projects			
	Septic BMPs	Conduct outreach to homeowners through targeted mailings, social media, local contractors, and public displays			
		Complete 20 septic repairs/replacements			
	Riparian Buffers	Work with local governments on strengthening riparian buffer ordinances			
		Complete 2 riparian buffer enhancement/restoration projects			
	Pet Waste Stations	Install 2 pet waste stations			
Supplemental BMPs, as funding and resources allow	*Shoreline Management*	Work with utilities to reach out to shoreline landowners and ensure compliance with the Shoreline Management Plan			
	Wetland Restoration	Monitor development impacts to wetlands and recommend mitigation options			
	Stormwater BMPs	If needed, recommend strengthened regulations outside of MS4 requirements			
		BMP demonstration site(s) identification, design, and cost evaluation			
	Wildlife BMPs	Send out targeted mailings to landowners about wildlife management			
	Send out surveys to participating landowners				
	Revise outreach and implementation strategies as needed				
	Complete quarterly updates on project website				
	Provide quarterly email and updates to stakeholders				

Table 55. Project Milestones Phase 3: Years 7-10						
Action Items			Years (7-10)			
			7	8	9	10
Required BMPs to meet load reductions	*Land Protection*	If needed, facilitate the closing of 1-2 conservation easements (or 55+ acres) and/or other land protection strategies				
	Agricultural BMPs	Conduct outreach and education to landowners through cooperating agencies				
		Send out targeted mailings to high priority landowners				
		Complete 4 agricultural BMP projects				
	Septic BMPs	Conduct outreach to homeowners through targeted mailings, social media, local contractors, and public displays				
		Complete 20 septic repairs/replacements				
	Riparian Buffers	Conduct outreach and education to landowners, including targeted mailings to high priority landowners				
		Complete 3 riparian buffer enhancement/restoration projects				
Supplemental BMPs, as funding and resources allow	*Shoreline Management*	Work with utilities to reach out to shoreline landowners and ensure compliance with the Shoreline Management Plan				
	Wetland Restoration	Monitor development impacts to wetlands and recommend mitigation options				
	Stormwater BMPs	If needed, recommend strengthened regulations outside of MS4 requirements				
		Install 1-2 stormwater BMP demonstration site(s) or projects				
	Wildlife BMPs	Send out targeted mailings to landowners about wildlife management				
	Send out surveys to participating landowners					
	Revise outreach and implementation strategies as needed					
	Complete quarterly updates on project website					
	Provide quarterly email and updates to stakeholders					
	Project wrap-up and final summary of projects/results					

22) WATER QUALITY MONITORING

Instream monitoring is used to assess baseline conditions of streams as well as changes or improvements in stream conditions after BMP projects have been installed. The water quality monitoring plan proposed below includes suggested sampling locations, parameters to be monitored, sample collection protocol, recommended microbial detection techniques, and potential individuals and/or organizations to conduct water sampling.

22.1) Proposed Monitoring Locations

Instream water quality monitoring is important for measuring current conditions as well as gauging the recovery of the streams after BMP projects have been installed. In the focus area, the priority sample site is the existing SCDHEC water quality monitoring location (SV-111). There are two inactive sites in the region, and three special study sites. It is recommended to reinstate monitoring at these inactive sites to gather a more comprehensive picture of water quality in the region.

In the case of impaired streams, additional water samples should be taken upstream of current TMDL sites in areas where land use activities have the potential to contribute bacteria to waterways (e.g., agricultural land near streams, urban areas, and residential properties). If the samples collected indicate high bacteria or turbidity levels, additional samples should be collected further upstream until the source area is identified. Furthermore, prior to the installation of any BMP projects is it suggested that sampling take place at the nearest feasible downstream location so that changes in water quality can be documented over time.

22.2) Monitoring Frequency

Instream monitoring should occur at each of the proposed sites in the watershed. Ideally, monitoring should occur on a monthly basis during a variety of hydrological conditions, and water samples should be taken before and after a project is installed. It is highly recommended that water samples continue to be collected on a monthly basis downstream of project sites for at least a year after installation. Monitoring data should be analyzed on a quarterly basis to identify trends, sources of pollution, and any changes in quality as a result of completed projects. Evaluating monitoring results by *E.coli* bacteria standards can determine percent attainment relating to water quality goals.

22.3) Microbial Source Detection Techniques

There are a variety of methods for analyzing bacteria in source waters. For the purposes of this project, we will focus on the most common methods: Most Probable Number (MPN) Method and Microbial Source Tracking.

22.3.1) Most Probable Number (MPN) Method

Water samples will be processed for *E. coli* using the Most Probable Number (MPN) method of detection. This type of analysis is based on the presence or absence of bacteria. Water samples will be processed using the U.S EPA approved standard for detection of total coliforms and *E. coli*, the IDEXX Colilert method for Coliform/*E. coli* (IDEXX, 2013).

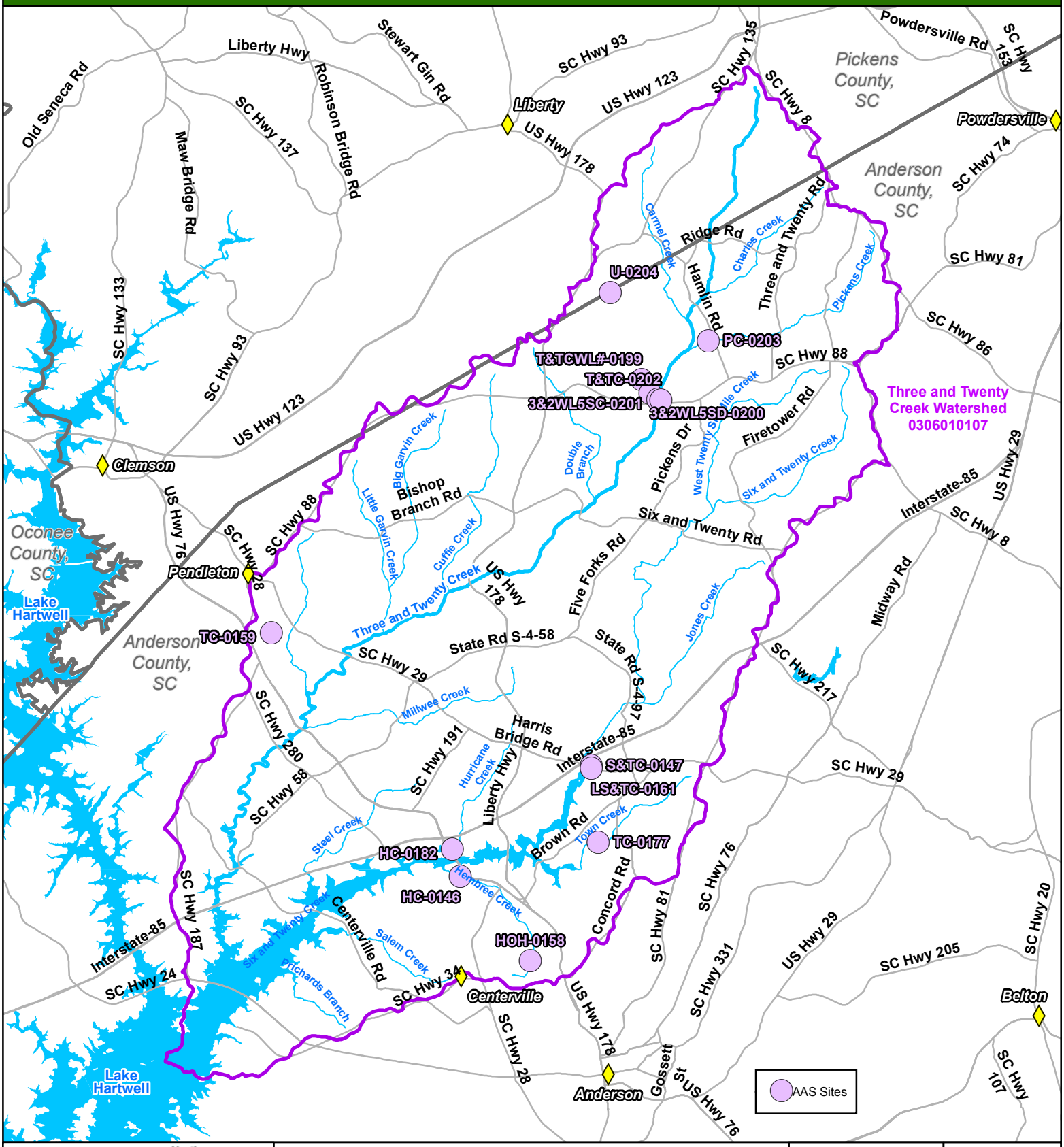
22.3.2) Microbial Source Tracking

Microbial Source Tracking (MST), also known as Bacterial Source Tracking, is a method used to discern sources of fecal contamination in surface waters. This method is capable of determining if the source of fecal contamination is human, wildlife, domestic livestock, pets, or a combination of sources. MST could prove to be a useful tool for bacterial source detection in the focus area if funding and resources are available. Currently, Clemson University is piloting a technical service, using qPCR, quantitative polymerase chain reaction, to quantify bacteria loading from warm-blooded mammals (e.g., swine, bovine, human, and dog) in surface waters. The cost per sample is $350. Tests are being conducted in partnership with the Clemson University Molecular Plant Pathogen Detection Lab and will provide valuable information to SC water resource managers (http://www.clemson.edu/public/water/watershed/projects, 2018).

22.4) Voluntary Water Quality Monitoring

Voluntary monitoring programs are an excellent way to engage citizens in enriching activities while assessing water quality in a region. SC Adopt-a-Stream (SC AAS), www.SCadoptastsream.org, is an ideal program to involve local citizens in monitoring water quality in the Three and Twenty Watershed. Schools, community groups, and interested citizens are great candidates for voluntary monitoring programs. Currently there are 13 active SC AAS sites in the focus area (SC AAS, 2018). The information obtained through voluntary monitoring programs is extremely valuable and increases our understanding of water quality in areas that SCDHEC is unable to monitor. Anderson and Pickens County Stormwater Partners and UF are both certified SC AAS trainers with years of sampling and teaching experience. These organizations will actively seek participants interested in monitoring water quality in this watershed.

Figure 31: Adopt-A-Stream Monitoring Sites



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Appendix A. Cooperating Organizations

- **Anderson County Stormwater Department** - The Stormwater Manager will provide available data, participate in the stakeholder group, and assist in the identification of areas in need of Best Management Practices (BMPs).

- **Anderson Regional Joint Water System (ARJWS)** - The Staff from ARJWS will engage in the stakeholder process by attending meetings, providing water quality data and background as needed, assisting in the identification of potential problem areas, development of BMPs, identification of priority parcels for protection, assist in watershed-based plan development, and aid in public outreach efforts.

- **Anderson and Pickens Counties Stormwater Partners (APCSP)** - Staff from Anderson and Pickens County Stormwater Partners will provide pertinent data and resources, participate in the stakeholder group process, and assist with the development of the plan, in particular the public outreach component. This group will also be able to assist Upstate Forever in the development of useful outreach materials for a variety of BMPs.

- **Lake Hartwell Association (LHA)** - The LHA has committed to participate in the stakeholder process by attending meetings, providing input to the development of the watershed-based plan, aiding in the identification of problem areas in the community, and possibly assisting with outreach to the local residents.

- **Pickens County Stormwater Department** - The Stormwater Manager will provide available data, participate in the stakeholder group, and assist in the identification of areas in need of BMPs in the focus area.

- **Three and Twenty Watershed District** – The Three and Twenty Watershed District is an elected board that oversees watershed related activities in the area under the supervision of the Anderson County Soil and Water Conservation District. The Board has committed to participating in the stakeholder process by attending meetings, providing input to the development of the watershed-based plan, aiding in the identification of problem areas in the community, and possibly assisting with outreach to the local residents.

Appendix B. Parks and Pet-related Businesses

Table 56. List of City and County Parks

Name	Address	Subwatershed
Anderson Sports and Entertainment Center/ Whitehall Park	3027 Martin Luther King Jr Blvd, Anderson, SC 29625	Lower Six and Twenty Creek
Asbury Campground and Boat Ramp	end of Asbury Road, Anderson, SC 29625	Lower Three and Twenty Creek
Barrett's Place/Veteran's Park	500 Lebanon Road # A, Pendleton, SC 29670	Lower Three and Twenty Creek
Brown Road Boat Ramp	end of C-10-198A, Anderson, SC 29621	Lower Six and Twenty Creek
Chris Taylor Memorial Park/Kid Venture	5 Jim Ed Rice Circle, Anderson, SC 29625	Lower Six and Twenty Creek
Darwin H Wright Municipal Park	end of Anderson Beach Blvd, Anderson, SC 29621	Lower Six and Twenty Creek
Dennis R Helpler Memorial Park at Whitehall Elementary	702 Whitehall Road, Anderson, SC 29625	Lower Six and Twenty Creek
Denver Boat Ramp	end of Denver Road, Anderson, SC 29625	Lower Six and Twenty Creek
Ducworth/Tucker Sports Park	1939 Evergreen Road, Anderson, SC 29621	Upper Six and Twenty Creek
Green Pond Landing and Event Center	470 Green Pond Road, Anderson, SC 29626	Lower Six and Twenty Creek
Honea Path Park Boat Ramp	end of Honea Path Road, Anderson, SC	Lower Six and Twenty Creek
Hurricane Creek Landing Boat Ramp	end of George Smith Mill Road, Anderson, SC 29625	Lower Six and Twenty Creek
Jacks Landing	end of Whitehall Road, Anderson, SC 29626	Lower Six and Twenty Creek
Michelin Baseball Field	507 Boscobel Road, Anderson, SC 29625	Lower Three and Twenty Creek
Pendleton Elementary Track	502 E Queen Street, Pendleton, SC 29670	Lower Three and Twenty Creek
Portman Marina	1629 Marina Road, Anderson, SC 29625	Lower Six and Twenty Creek
Sandy Springs Track	1198 State Highway 280, Anderson, SC 29625	Lower Three and Twenty Creek
Sister City Park	113 Liberty Hall Drive, Pendleton, SC 29670	Lower Three and Twenty Creek

White City Boat Ramp	end of C-9-33, Anderson, SC 29625	Lower Six and Twenty Creek

Table 57. List of Groomers, Kennels, Veterinarians, and Pet-Related Businesses

Name	Address	Subwatershed
Creek Run Veterinary Clinic	2929 6 and 20 Road, Pendleton, SC 29670	Upper Three and Twenty Creek
Outlaw Veterinary Clinic	4348 Pelzer Highway, Easley, SC 29642	Upper Three and Twenty Creek
Walker Animal Hospital	3810 N Highway 81, Anderson, SC 29621	Upper Six and Twenty Creek
Town N' Country Pet Grooming	6600 US-76, Pendleton, SC 29670	Lower Three and Twenty Creek
Magnolia Veterinary Clinic	2828 E North Avenue, Anderson, SC 29625	Lower Six and Twenty Creek
Ultra Pet Company	4325 Old Mill Road, Anderson, SC 29621	Lower Six and Twenty Creek
PetSmart	3523 Clemson Blvd, Anderson, SC 29621	Lower Six and Twenty Creek

Appendix C. Standard Numbers

Standard Numbers as provided by SCDHEC (12/11/2015)
(#s in parentheses are reference #s!)

Loading

Septic: (*1, load from one septic tank per the StepL septic input page, 2, from Septic tab in WCS per Horsley and Whitten 1999*)

- Bacteria: 2.76 x10E6/hr*24*365=2.4176 E10 per household
- Nitrogen: 31.1lb/yr (1)
- Phosphorus: 12.2 lb/yr

Cattle: (Beef) in Streams=Direct Input to Stream: (Ref 5, assumes year round spring deposition rate)
Bacteria 5.4xE8(5) bacteria/day/cow(5) * 365=1.97 x E11/yr/cow
Phosphorus: 0.004lbsP/day/cow(5) * 365=0.73 lbs/yr/cow
Nitrogen: 0.005lbsN/day/cow (5) * 365= 1.83 lbs/yr/cow

Fecal Colonies (#/animal/day) (4)

- Chicken (layers) -1.36 x 10E8
- Turkey - 9.3 x 10E7
- Hogs - 1.08 x 10E10
- Horse - 4.20 x 10E8

Dog Waste Bacteria Loading

- Dog 4.09x E09 bacteria/day

Livestock Equivalents (Mass of Waste produced per day, in PBCE (pasture beef cow equivalents).

- Beef Cow 1
- Dairy Cow 2.6
- Horse 1.1
- Hog 0.24
- Sheep 0.04
- Goat 0.04
- Camel 0.5
- Llama 0.5
- Dog 0.01

Table below is the amount of FC bacteria available for deposit on the watershed per individual animal per year (100 % does **not** wash off)

Annual Fecal Coliform Bacterial Loading (cfu/year) for Livestock Animals		
Livestock	**cfu/year**	**Reference**
Cow	1.97E+12	Metcalft and Eddy, 1991
Horse	1.53E+11	ASAE, 1998
Hog	3.63E+12	Metcalft and Eddy, 1991 ASAE, 1998
Sheep	1.10E+13	Metcalft and Eddy, 1991 ASAE, 1998
Hen	4.61E+10	Calculated from fecal waste of chicken (cfu/year) multiplied by hen:chicken mass ratio
Goat	1.10E+13	(Assumed same as sheep)
Chicken	1.39E+11	Metcalft and Eddy, 1991 ASAE, 1998

Source:
http://www.crwr.utexas.edu/gis/gishydro05/Modeling/WaterQualityModeling/BacteriaModel.htm

Land Use: Annual Pollutant Loadings from Land Use per Unit Area
Annual Pollutant Loads by Land Use (kg/ha/year) Pounds multiply by 2.2, acres multiply by 0.404

LANDUSE		TSS	TP	TN	Pb	In	Cu	FC
ROAD	MINIMUM	281	0.59	1.3	0.49	0.18	0.03	7.10E+07
	MAXIMUM	723	1.5	3.5	1.1	0.45	0.09	2.80E+08
	MEDIAN	502	1.1	2.4	0.78	0.31	0.06	1.80E+08
Commercial	MINIMUM	242	0.69	1.6	1.6	1.7	1.1	l.7E+09
	MAXIMUM	1,369	0.91	8.8	4.7	4.9	3.2	9.50E+09
	MEDIAN	805	0.8	5.2	3.1	3.3	2.1	5.60E+09
Single Fam Residential Low density	MINIMUM	60	0.46	3.3	0.03	0.07	0.09	2.80E+09
	MAXIMUM	340	0.64	4.7	0.09	0.2	0.27	1.6E+l0
	MEDIAN	200	0.55	4	0.06	0.13	0.18	9.30E+09
Single Fam Residential HighDensity	MINIMUM	97	0.54	4	0.05	0.11	0.15	4.50E+09
	MAXIMUM	547	0.76	5.6	0.15	0.33.	0.45	2.6E+l0
	MEDIAN	322	0.65	5.8	0.1	0.22	0.3	1.5E+l0
Multi Fam Residential	MINIMUM	133	0.59	4.7	0.35	0.17	0.17	6.30E+09
	MAXIMUM	755	0.81	6.6	1.05	0.51	0.34	3.6E+l0
	MEDIAN	444	0.7	5.6	0.7	0.34	0.51	2.1E+l0
Forest	MINIMUM	26	0.1	1.1	0.01	0.01	0.02	1.20E+09
	MAXIMUM	146	0.13	2.8	0.03	0.03	0.03	6.80E+09
	MEDIAN	86	0.11	2	0.02	0.02	0.03	4.00E+09
Grass	MINIMUM	80	0.01	1.2	0.03	0.02	0.02	4.80E+09
	MAXIMUM	588	0.25	7.1	0.1	0.17	0.04	2.7E+l0
	MEDIAN	346	0.13	4.2	0.07	0.1	0.03	1.60E+10
Pasture	MINIMUM	103	0.01	1.2	0.004	0.02	0.02	4.80E+09
	MAXIMUM	583	0.25	7.1	0.015	0.17	0.04	2.70E+10
	MEDIAN	343	0.13	4.2	0.01	0.1	0.03	1.60E+10

Source: Shaver, Ed, et al "Fundamentals of Urban Runoff: Technical and institutional issues: 2nd edition, 2007

Conversions: Multiply above by 0.45 then 0.404 to get number for lb/ac/yr
Just for bacteria: Multiply above by 0.404 to get number of bacteria/acre-year
Cropland (9) FC loading per unit area (#/ha)
No manure 9.50E+10
Poultry litter applied 6.50E+12
Dairy litter applied 1.75E+12

Concentrations:
Average Concentration of Bacteria in runoff by landuse (per 100 ml)
FC *E-Coli*(8)
Urban: 2.40E+04, 8429
Forest: 204
AgCrop (surface) (9)
No manure applied: 1.30E+04
Poultry litter applied: 5.70E+05
Dairy manure applied: 2.30E+05
AgPasture: 2375

References:
1) STEP_L model
2) Watershed Characterization System References Tab, Septics Tab
3) US EPA July 2003 National Management Measures for the Control of Nonpoint Pollution from Agriculture. EPA-841-B-03-004
4) ASAE 1998 ASAE Standards 45 edition Standards Engineering Practices Data pp 646 (With EPA Region IV input)
5) University of California Extension Fact Sheet No 25. Manure Loading into Streams from Direct Fecal Deposits
6) http://dnrweb.dnr.state.md.us/watersheds/surf/bmp/swbmp.asp
7)http://rpitt.eng.ua.edu/Publications/4_Stormwater_Characteristics_Pollutant_Sources_and_Land_Development_Characteristics/Stormwater_characteristics_and_the_NSQD/NSQD%203.1%20summary%20for%20EPA%20Cadmus.pdf
8) Mednick A. C. "Development of a Tool for Predicting and Reducing Bacterial Contamination at Great Lakes Beaches." Wisconsin DNR, Oct 20011.
9) Mishra A. et al. "Bacterial Transport from Agricultural Lands Fertilized with Animal Manure". Water Air and Soil Pollution 189:127-134. (2008)

Appendix D. Typical Agricultural BMP Bundle and Bacteria Removal Calculations

Typical Agricultural BMP Bundle:Agricultural BMPs are most often installed in packages, or combinations of multiple BMPs.The SC DHEC Nonpoint Source Management Program 2012 Annual Report outlines several current and past 319 projects for both agriculture and septic BMPs.

Within the Upstate region of South Carolina, there have been five completed 319 projects that have focused predominantly on either septic or agricultural BMPs. The five projects completed various combinations of agricultural and/or septic BMPs, shown in the table below.

TMDL/ 319 Project	Total Fecal Coliform Removal (CFU)	Alternative Water Sources (units)	Controlled Stream Access for Livestock Watering (ft)	Fence (ft)	Water Well (units)	Heavy Use Area Protection (sq. ft)	Pipeline (ft)	Watering Facilities (units)	Vegetated Riparian Buffers (ac)	Onsite Wastewater Treatment System (units)	Streambank and Shoreline Protection (ft)
Rabon Creek	3.87E+13	2	152	3,143		10,918		1	2	43	
Cane/ Little Cane Creek	6.22E+11									17	2,644
Long Cane Creek	2.87E+12	5		3,735		23,491				9	41,916
Twelve Mile Creek	1.34E+14	4		57,122	14	55,391	14,135	44	10		29,267
Tyger River	3.14E+12	19		27,385	5	14,994	15,193			57	27,385
Total	***1.79E+14***	***30***	***152***	***91,385***	***19***	***104,794***	***29,328***	***45***	***12***	***126***	***101,212***

Looking only at the agricultural BMPs, which would include all but the onsite wastewater treatment system projects, there are only a few BMPs that are measured in units: watering facilities, water wells and alternative watering sources. Out of these three BMPs, water wells have the lowest total number of installations. Using this, we can assume that for every one waste well that is installed, there is an average of 1868 feet of fencing, 2138 square feet of heavy use area protection, 599 feet of pipeline, 2 watering facilities, and 0.23 acres of riparian buffer installed. An average agricultural BMP bundle therefore looks like this:

Average Agricultural BMP Bundle:

- 1 well with pump
- 1,686 feet of fencing
- 2,138 square feet of Heavy Use Area protection
- 599 linear feet of waterline
- 1 watering facility
- 0.23 acres of riparian buffer area

Average Bacteria Removal: The SC DHEC Nonpoint Source Management Program 2012 Annual Report contains total fecal coliform removed from all septic and agricultural BMP project combined.

Appendix D. Typical Agricultural BMP Bundle and Bacteria Removal Calculations

To determine the average fecal coliform bacteria one BMP bundle removes it is necessary to separate fecal reductions from septic and agricultural BMPs.

Since the Cane/Little Cane Creek project dealt exclusively with septic projects, we can determine the average bacteria reductions from a septic project.

$$\text{Average Septic Project Fecal Coliform Reductions} = \frac{\text{Total \# Septic Projects Completed}}{\text{Total Fecal Coliform Reduction}}$$

TMDL/319 Project	Total Fecal Coliform Removal (CFU)	Onsite Wastewater Treatment System Projects (units)	Average Fecal Coliform Removed by 1 Septic Project
Cane/Little Cane Creek	6.22E+11	17	3.66E+10

The average septic project fecal coliform reduction can then be used to calculate the average reduction of an agriculture BMP bundle. Since the Rabon Creek 319 project had both septic and agricultural BMPs, we can determine the agricultural reduction by removing the total bacteria removed from septic.

TMDL/ 319 Project	Total Fecal Coliform Removal (CFU)	Alternative Water Sources (units)	Controlled Stream Access for Livestock Watering (ft)	Fence (ft)	Water Well (units)	Heavy Use Area Protection (sq. ft)	Pipeline (ft)	Watering Facilities (units)	Vegetated Riparian Buffers (ac)	Onsite Wastewater Treatment System (units)	Streambank and Shoreline Protection (ft)
Rabon Creek	3.87E+13	2	152	3,143		10,918		1	2	43	

The table above shows all of the projects installed during the Rabon Creek 319 project. Using the calculated average septic reduction, the 43 septic projects removed 1.57E+12 CFU of fecal coliform. Subtracting this number from the total fecal coliform removal gives us the remaining reductions, 3.71E+13 CFU that resulted from agricultural BMPs.

Using the average agriculture BMP bundle calculations from earlier, we can assume that the Rabon Creek 319 funds installed about 2 average agricultural BMP bundles.

TMDL/319 Project	Fecal Coliform Removal from Septic Projects	Remaining Fecal Coliform Removal (total septic removal)	Number of Agricultural BMP Bundles Installed	Average Fecal Coliform Removal from Agricultural BMP Bundles
Rabon Creek	(43*3.66E+10)=1.57E+12	(3.87E+13-1.57E+12) = 3.71E+13	2	(3.71E+13/2) = 1.86E+13

Dividing the total agricultural BMP removal by the 2 installed agricultural BMPs results in an average fecal coliform reduction of 1.86E+13 CFU per agricultural BMP bundle.

Appendix E. STEPL Riparian Buffer Tool Screenshots

Date: 8/6/2018
Organization Name:
Project Name:
Grant Number:

Total Load

1. Total load by subwatershed(s)

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)	E. coli Load (no BMP)	N Reduction	P Reduction	BOD Reduction	Sediment Reduction	E. coli Reduction
	lb/year	lb/year	lb/year	t/year	Billion MPN/year	lb/year	lb/year	lb/year	t/year	Billion MPN/year
W1	537787.4	97326.8	1903043.0	11032.0	0.0	0.0	0.0	0.0	0.0	0.0
W2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	537787.4	97326.8	1903043.0	11032.0	0.0	0.0	0.0	0.0	0.0	0.0

N Load (with BMP)	P Load (with BMP)	BOD (with BMP)	Sediment Load (with BMP)	E. coli Load (with BMP)	%N Reduction	%P Reduction	%BOD Reduction	%Sed Reduction	%E. coli Reduction
lb/year	lb/year	lb/year	t/year	Billion MPN/year	%	%	%	%	%
537787.4	97326.8	1903043.0	11032.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
537787.4	97326.8	1903043.0	11032.0	0.0	0.0	0.0	0.0	0.0	0.0

2. Total load by land uses (with BMP)

Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)	E. coli Load (Billion MPN/yr)
Urban	201136.20	30959.57	775536.93	4616.24	0.00
Cropland	6874.87	1535.21	9918.99	154.34	0.00
Pastureland	224297.35	22469.51	706195.38	5692.76	0.00
Forest	11623.60	5602.52	28149.08	568.70	0.00
Feedlots	0.00	0.00	0.00	0.00	0.00
User Defined	0.00	0.00	0.00	0.00	0.00
Septic	93855.33	36760.00	383242.58	0.00	0.00
Gully	0.00	0.00	0.00	0.00	0.00
Streambank	0.00	0.00	0.00	0.00	0.00
Groundwater	0.00	0.00	0.00	0.00	0.00
Total	537787.35	97326.81	1903042.96	11032.04	0.00

Input

State	County	Weather Station
South Carolina	Anderson	_SC-Anderson_Mean

									Rain correction factors		
1. Input watershed land use area (ac) and precipitation (in)									0.931	0.601	
Watershed	Urban	Cropland	Pastureland	Forest	User Defined	Feedlots	Feedlot Percent Paved	Total	Annual Rainfall	Rain Days	Avg. Rain/Event
3&20	22530	163	28181	37537	0	0	0-24%	88411	50	103	0.754
	0	0		0	0	0	0-24%	0	50	103	0.754
	0	0	0	0	0	0	0-24%	0	50	103	0.754
	0	0	0	0	0	0	0-24%	0	50	103	0.754
	0	0	0	0	0	0	0-24%	0	50	103	0.754
	0	0	0	0	0	0	0-24%	0	50	103	0.754
	0	0	0	0	0	0	0-24%	0	50	103	0.754
	0	0	0	0	0	0	0-24%	0	50	103	0.754
	0	0	0	0	0	0	0-24%	0	50	103	0.754
	0	0	0	0	0	0	0-24%	0	50	103	0.754

2. Input agricultural animals										
Watershed	Beef Cattle	Dairy Cattle	Swine (Hog)	Sheep	Horse	Chicken	Turkey	Duck	# of months manure applied on Cropland	# of months manure applied on Pastureland
3&20	3324	1000	162	170	646	295887	0	0	9	6
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
Total	3324	1000	162	170	646	295887	0	0		

3. Input septic system and illegal direct wastewater discharge data

Watershed	No. of Septic Systems	Population per Septic System	Septic Failure Rate, %	Wastewater Direct Discharge, # of People	Direct Discharge Reduction, %
3&20	15095	2.43	20	0	0
	0	2.43	20	0	0
	0	2.43	20	0	0
	0	2.43	2	0	0
	0	2.43	2	0	0
	0	2.43	2	0	0
	0	2.43	2	0	0
	0	2.43	2	0	0
	0	2.43	2	0	0
	0	2.43	2	0	0

4. Modify the Universal Soil Loss Equation (USLE) parameters

Watershed	Cropland					Pastureland					Forest					User Defined				
	R	K	LS	C	P	R	K	LS	C	P	R	K	LS	C	P	R	K	LS	C	P
W1	274.756	0.266	0.788	0.200	0.937	274.756	0.266	0.788	0.040	1.000	274.756	0.266	0.788	0.003	1.000	274.756	0.266	0.788	0.065	1.000
W2	274.756	0.266	0.788	0.200	0.937	274.756	0.266	0.788	0.040	1.000	274.756	0.266	0.788	0.003	1.000	274.756	0.266	0.788	0.065	1.000
W3	274.756	0.266	0.788	0.200	0.937	274.756	0.266	0.788	0.040	1.000	274.756	0.266	0.788	0.003	1.000	274.756	0.266	0.788	0.065	1.000
W4	274.756	0.266	0.788	0.200	0.937	274.756	0.266	0.788	0.040	1.000	274.756	0.266	0.788	0.003	1.000	274.756	0.266	0.788	0.065	1.000
W5	274.756	0.266	0.788	0.200	0.937	274.756	0.266	0.788	0.040	1.000	274.756	0.266	0.788	0.003	1.000	274.756	0.266	0.788	0.065	1.000
W6	274.756	0.266	0.788	0.200	0.937	274.756	0.266	0.788	0.040	1.000	274.756	0.266	0.788	0.003	1.000	274.756	0.266	0.788	0.065	1.000
W7	274.756	0.266	0.788	0.200	0.937	274.756	0.266	0.788	0.040	1.000	274.756	0.266	0.788	0.003	1.000	274.756	0.266	0.788	0.065	1.000
W8	274.756	0.266	0.788	0.200	0.937	274.756	0.266	0.788	0.040	1.000	274.756	0.266	0.788	0.003	1.000	274.756	0.266	0.788	0.065	1.000
W9	274.756	0.266	0.788	0.200	0.937	274.756	0.266	0.788	0.040	1.000	274.756	0.266	0.788	0.003	1.000	274.756	0.266	0.788	0.065	1.000
W10	274.756	0.266	0.788	0.200	0.937	274.756	0.266	0.788	0.040	1.000	274.756	0.266	0.788	0.003	1.000	274.756	0.266	0.788	0.065	1.000

Optional Data Input:

5. Select average soil hydrologic group (SHG), SHG A = highest infiltration and SHG D = lowest infiltration

Watershed	SHG A	SHG B	SHG C	SHG D	SHG Selected	Soil N conc.%	Soil P conc.%	Soil BOD conc.%	Soil E. coli conc. (#/100mg)
W1					B	0.080	0.031	0.160	0.000
W2					B	0.080	0.031	0.160	0.000
W3					B	0.080	0.031	0.160	0.000
W4					B	0.080	0.031	0.160	0.000
W5					B	0.080	0.031	0.160	0.000
W6					B	0.080	0.031	0.160	0.000
W7					B	0.080	0.031	0.160	0.000
W8					B	0.080	0.031	0.160	0.000
W9					B	0.080	0.031	0.160	0.000
W10					B	0.080	0.031	0.160	0.000

6. Reference runoff curve number (may be modified)

SHG	A	B	C	D
Urban	83	89	92	93
Cropland	67	78	85	89
Pastureland	49	69	79	84
Forest	39	60	73	79
User Defined	50	70	80	85

6a. Detailed urban reference runoff curve number (may be modified)

Urban\SHG	A	B	C	D
Commercial	89	92	94	95
Industrial	81	88	91	93
Institutional	81	88	91	93
Transportation	98	98	98	98
Multi-Family	77	85	90	92
Single-Family	57	72	81	86
Urban-Cultivated	67	78	85	89
Vacant-Developed	77	85	90	92
Open Space	49	69	79	84

7. Nutrient concentration in runoff (mg/l) and E. coli (MPN/100ml)

Land use	N	P	BOD	E. coli
1. L-Cropland	**1.9**	**0.3**	**4**	0
1a. w/ manure	8.1	2	12.3	0
2. M-Cropland	**2.9**	**0.4**	**6.1**	0
2a. w/ manure	12.2	3	18.5	0
3. H-Cropland	**4.4**	**0.5**	**9.2**	0

3a. w/ manure	18.3	4	24.6	0
4. Pastureland (see Table 10 for default values with manure)				
5. Forest	**0.2**	**0.1**	**0.5**	0
6. User Defined	**0**	**0**	**0**	0

7a. Nutrient concentration in shallow groundwater (mg/l) and E. coli (MPN/100ml)(may be modified)

Landuse	N	P	BOD	E. coli
Urban	1.5	0.063	0	0
Cropland	1.44	0.063	0	0
Pastureland	1.44	0.063	0	0
Forest	0.11	0.009	0	0
Feedlot	6	0.07	0	0
User-Defined	0	0	0	0

8. Input or modify urban land use distribution

Watershed	Urban Area (ac.)	Commercial %	Industrial %	Institutional %	Transportation %	Multi-Family %	Single-Family %	Urban-Cultivated %	Vacant (developed) %	Open Space %	Total % Area
W1	22530	15	10	10	10	10	30	5	5	5	100
W2	0	15	10	10	10	10	30	5	5	5	100
W3	0	15	10	10	10	10	30	5	5	5	100
W4	0	15	10	10	10	10	30	5	5	5	100
W5	0	15	10	10	10	10	30	5	5	5	100
W6	0	15	10	10	10	10	30	5	5	5	100
W7	0	15	10	10	10	10	30	5	5	5	100
W8	0	15	10	10	10	10	30	5	5	5	100
W9	0	15	10	10	10	10	30	5	5	5	100
W10	0	15	10	10	10	10	30	5	5	5	100

9. Input irrigation area (ac) and irrigation amount (in)

Watershed	Total Cropland (ac)	Cropland: Acres Irrigated	Water Depth (in) per Irrigation - Before BMP	Water Depth (in) per Irrigation - After BMP	Irrigation Frequency (#/Year)
W1	163	0	0	0	0
W2	0	0	0	0	0
W3	0	0	0	0	0
W4	0	0	0	0	0
W5	0	0	0	0	0
W6	0	0	0	0	0

W7	0	0	0	0	0
W8	0	0	0	0	0
W9	0	0	0	0	0
W10	0	0	0	0	0

10. Pastureland Nutrient concentration in runoff (mg/l) and E. coli (MPN/100ml)

Land use	N	P	BOD	E. coli
1. L-Pastureland	**4**	**0.3**	**13**	0
1a. w/ manure	4	0.3	13	0
2. M-Pastureland	**4**	**0.3**	**13**	0
2a. w/ manure	4	0.3	13	0
3. H-Pastureland	**4**	**0.3**	**13**	0
3a. w/ manure	4	0.3	13	0

BMPs

1. BMPs and efficiencies for different pollutants on CROPLAND, ND=No Data

Watershed	Cropland						
	N	P	BOD	Sediment	E. coli	BMPs	% Area BMP Applied
W1	0.00	0.00	0.00	0.00	0.00	0 No BMP	50.00
W2	0.00	0.00	0.00	0.00	0.00	0 No BMP	50.00
W3	0.00	0.00	0.00	0.00	0.00	0 No BMP	50.00
W4	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W5	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W6	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W7	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W8	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W9	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W10	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00

2. BMPs and efficiencies for different pollutants on PASTURELAND, ND=No Data

Watershed	Pastureland						
	N	P	BOD	Sediment	E. coli	BMPs	% Area BMP Applied
W1	0.00	0.00	0.00	0.00	0.00		100.00
W2	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W3	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W4	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W5	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W6	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W7	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W8	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W9	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W10	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00

3. BMPs and efficiencies for different pollutants on FOREST, ND=No Data

Watershed	Forest						
	N	P	BOD	Sediment	E. coli	BMPs	% Area BMP Applied
South	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
Middle	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
North	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W4	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00

W5	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W6	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W7	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W8	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W9	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W10	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00

4. BMPs and efficiencies for different pollutants on USER DEFINED land use, ND=No Data

Watershed	**User Defined**						
	N	P	BOD	Sediment	E. coli	BMPs	% Area BMP Applied
W1	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W2	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W3	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W4	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W5	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W6	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W7	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W8	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W9	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W10	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00

5. BMPs and efficiencies for different pollutants on FEEDLOTS, ND=No Data

Watershed	**Feedlots**						
	N	P	BOD	Sediment	E. coli	BMPs	%Area BMP Applied
W1	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W2	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W3	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W4	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W5	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W6	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W7	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W8	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W9	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00
W10	0.00	0.00	0.00	0.00	0.00	0 No BMP	0.00

7. Combined watershed BMP efficiencies from the BMP calculator

Watershed	Watershed Combined BMP Efficiencies					
	N	P	BOD	Sediment	E. coli	BMPs
W1-Crop	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W2-Crop	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W3-Crop	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W4-Crop	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W5-Crop	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W6-Crop	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W7-Crop	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W8-Crop	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W9-Crop	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W10-Crop	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W1-Pasture	0.00	0.00	0.00	0.60	0.00	Combined BMPs
W2-Pasture	0.00	0.00	0.00	0.60	0.00	Combined BMPs
W3-Pasture	0.00	0.00	0.00	0.60	0.00	Combined BMPs
W4-Pasture	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W5-Pasture	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W6-Pasture	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W7-Pasture	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W8-Pasture	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W9-Pasture	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W10-Pasture	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W1-Forest	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W2-Forest	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W3-Forest	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W4-Forest	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W5-Forest	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W6-Forest	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W7-Forest	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W8-Forest	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W9-Forest	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W10-Forest	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W1-User	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W2-User	0.00	0.00	0.00	0.00	0.00	Combined BMPs

W3-User	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W4-User	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W5-User	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W6-User	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W7-User	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W8-User	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W9-User	0.00	0.00	0.00	0.00	0.00	Combined BMPs
W10-User	0.00	0.00	0.00	0.00	0.00	Combined BMPs

Urban

1. Urban pollutant concentration in runoff (mg/l) and E. coli (MPN/100ml)

Landuse	Commercial	Industrial	Institutional	Transportation	Multi-Family	Single-Family	Urban-Cultivated	Vacant (developed)	Open Space
TN	2	2.5	1.8	3	2.2	2.2	1.9	1.5	1.5
TP	0.2	0.4	0.3	0.5	0.4	0.4	0.3	0.15	0.15
BOD	9.3	9	7.8	9.3	10	10	4	4	4
TSS	75	120	67	150	100	100	150	70	70
E. coli	0	0	0	0	0	0	0	0	0

2. Urban landuse distribution

Landuse	Commercial	Industrial	Institutional	Transportation	Multi-Family	Single-Family	Urban-Cultivated	Vacant (developed)	Open Space
W1	3379.5	2253	2253	2253	2253	6759	1126.5	1126.5	1126.5
W2	0	0	0	0	0	0	0	0	0
W3	0	0	0	0	0	0	0	0	0
W4	0	0	0	0	0	0	0	0	0
W5	0	0	0	0	0	0	0	0	0
W6	0	0	0	0	0	0	0	0	0
W7	0	0	0	0	0	0	0	0	0
W8	0	0	0	0	0	0	0	0	0
W9	0	0	0	0	0	0	0	0	0
W10	0	0	0	0	0	0	0	0	0

2a. Effective BMP application area (ac)

Landuse	Commercial	Industrial	Institutional	Transportation	Multi-Family	Single-Family	Urban-Cultivated	Vacant (developed)	Open Space
W1	3666	2444	2444	2444	2444	7332	1222	1222	1222
W2	1616.55	1077.7	1077.7	1077.7	1077.7	3233.1	538.85	538.85	538.85
W3	2214	1476	1476	1476	1476	4428	738	738	738
W4	0	0	0	0	0	0	0	0	0
W5	0	0	0	0	0	0	0	0	0
W6	0	0	0	0	0	0	0	0	0
W7	0	0	0	0	0	0	0	0	0
W8	0	0	0	0	0	0	0	0	0
W9	0	0	0	0	0	0	0	0	0
W10	0	0	0	0	0	0	0	0	0

3. Selected urban BMPs

Landuse	Commercial	Industrial	Institutional	Transportation	Multi-Family	Single-Family	Urban-Cultivated	Vacant (developed)	Open Space
W1	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP
W2	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP
W3	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP
W4	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP
W5	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP
W6	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP
W7	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP
W8	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP
W9	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP
W10	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP	0 No BMP

3a. Percentage of BMP effective area (%)

Landuse	Commercial	Industrial	Institutional	Transportation	Multi-Family	Single-Family	Urban-Cultivated	Vacant (developed)	Open Space
W1	108.478	108.478	108.478	108.478	108.478	108.478	108.478	108.478	108.478
W2	0	0	0	0	0	0	0	0	0
W3	0	0	0	0	0	0	0	0	0
W4	0	0	0	0	0	0	0	0	0
W5	0	0	0	0	0	0	0	0	0
W6	0	0	0	0	0	0	0	0	0
W7	0	0	0	0	0	0	0	0	0
W8	0	0	0	0	0	0	0	0	0
W9	0	0	0	0	0	0	0	0	0
W10	0	0	0	0	0	0	0	0	0

3.1. Urban runoff (ac-ft)

Landuse	Commercial	Industrial	Institutional	Transportation	Multi-Family	Single-Family	Urban-Cultivated	Vacant (developed)	Open Space
W1	6820.75	3572.96	3572.96	7186.45	3043.62	5116.33	1094.83	1521.81	757.983
W2	0	0	0	0	0	0	0	0	0
W3	0	0	0	0	0	0	0	0	0
W4	0	0	0	0	0	0	0	0	0
W5	0	0	0	0	0	0	0	0	0
W6	0	0	0	0	0	0	0	0	0
W7	0	0	0	0	0	0	0	0	0
W8	0	0	0	0	0	0	0	0	0
W9	0	0	0	0	0	0	0	0	0

W10	0	0	0	0	0	0	0	0	0

4. Pollutant loads from urban (lb/year) and E. coli (MPN/year)

Watershed	Pre-BMP Load					Load Reduction					After BMP Load				
	N	P	BOD	TSS	E. coli	N	P	BOD	TSS	E. coli	N	P	BOD	TSS	E. coli
W1	201136	30959.6	775537	9232484	0	0	0	0	0	0	201136	30959.6	775537	9232484	0
W2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

5. Captured Flow Volume (gallon/year)

Landuse	Commercial	Industrial	Institutional	Transportation	Multi-Family	Single-Family	Urban-Cultivated	Vacant (developed)	Open Space
W1	0	0	0	0	0	0	0	0	0
W2	0	0	0	0	0	0	0	0	0
W3	0	0	0	0	0	0	0	0	0
W4	0	0	0	0	0	0	0	0	0
W5	0	0	0	0	0	0	0	0	0
W6	0	0	0	0	0	0	0	0	0
W7	0	0	0	0	0	0	0	0	0
W8	0	0	0	0	0	0	0	0	0
W9	0	0	0	0	0	0	0	0	0
W10	0	0	0	0	0	0	0	0	0

6. BMP Surface Area (acre) or Number of Units (e.g., Rain Barrel)

Landuse	Commercial	Industrial	Institutional	Transportation	Multi-Family	Single-Family	Urban-Cultivated	Vacant (developed)	Open Space
W1	0	0	0	0	0	0	0	0	0
W2	0	0	0	0	0	0	0	0	0
W3	0	0	0	0	0	0	0	0	0
W4	0	0	0	0	0	0	0	0	0
W5	0	0	0	0	0	0	0	0	0

W6	0	0	0	0	0	0	0	0	0
W7	0	0	0	0	0	0	0	0	0
W8	0	0	0	0	0	0	0	0	0
W9	0	0	0	0	0	0	0	0	0
W10	0	0	0	0	0	0	0	0	0

Parcel Prioritization for Land Protection Criteria

1) Critical Watershed Area (CWA)

The Critical Watershed Area study was completed by Furman University using the InVEST model. The results of this analysis identified areas that, if developed, would have the biggest (negative) impact to water quality. Highest valued areas, if developed, would have significant negative impact to water quality, and are therefore the most important to protect.

Scoring: The Critical Watershed Area raster file created by Furman University was used to assign points to individual parcels based on higher potential water quality impacts. The average value per parcel was calculated; then the range of averaged values was separated into high, medium, and low priority categories. Because the results had a non-normal distribution, geometric intervals were used to divide them into three categories (high, medium, and low priority). Parcels designated high priority areas received "4" points; parcels designated medium priority areas were received "3" points; other parcels received "0" points

Critical Watershed Area Priority Ranges

Range	CWA Values
Low Priority Range	0 – 0.000004
Medium Priority Range	0.000005 – 0.000261
High Priority Range	0.000265 – 0.014961

GIS Layers Used: Parcel, Critical Watershed Area (Furman University, 2017).

2) Stream Order

First order, or headwater, streams are the smallest stream channels in a river network and are of increased importance to river/watershed health due to their ability to retain floodwater, store nutrients, reduce sediment, maintain base flow of rivers, and provide critical habitat. Loss of headwater streams can have significant negative impacts to water quality and watershed health, and are therefore very important to protect (TNC, 2016).

Scoring: Using the National Hydrology Dataset, parcels containing headwater (1st order) streams received "4" points. All other parcels received "0" points.

GIS Layers Used: Parcel, National Hydrology Dataset

3) Stream Classification

Streams that are in the most pristine condition are the most important to protect; once impacted they are difficult and expensive to restore. SCDHEC classifies streams throughout South Carolina; Outstanding Resource Waters are of "exceptional recreational or ecological importance or of unusual value" and Trout Waters Natural (TN) support natural populations and a "cold water balanced indigenous aquatic community of flora and fauna". Therefore, the ORW and TN waters are most important to protect from an ecological standpoint.

Scoring: Parcels that contained a stream, or portion thereof, were assigned points based on stream's classification. Parcels with streams classified as ORW or TN (i.e., highest quality

streams that are a priority for protection) received "4" points; parcels with streams classified as Trout Waters Grow Put Take (TGPT) received "3" points; parcels with streams classified as Freshwater (FW) and no stream impairments received "2" points. Parcels with streams classified as FW and at least one impairment received "1" point. Parcels without streams along/within their boundaries received "0" points.

GIS Layers Used: Parcel, Stream Classification

4) Highly Sensitive Riparian Buffer Areas

Riparian, or vegetated, stream buffers provide water quality benefits including slowing and filtering stormwater runoff, reducing flooding, preventing stream channelization, stabilizing streambanks, and minimizing erosion (Pennsylvania Land Trust Association, 2014). Protecting the most sensitive riparian buffers ensures that lands continue to provide valuable water quality benefits. For water quality protection, riparian buffer zones should be a minimum of 100 feet wide on each side of the waterbody (Fischer, 2000).

Scoring: UF identified highly sensitive riparian areas by combining the results from the USFS Riparian Buffer Delineation Model v.5.2 (www.riparian.solutions, run by UF) with a 100-foot buffer around all waterways (Abood et al., 2012 a, b). Parcels were assigned points according to acreage of highly sensitive riparian buffer areas within each parcel, based on the "natural breaks" in the resulting acreage data (partitioning data into classes based on natural groups in the data distribution). Parcels with 43 acres or more of highly sensitive riparian buffer acreage received "4" points; parcels with 20-42.99 acres of highly sensitive riparian buffer acreage received "3" points; parcels with 8-19.99 acres of highly sensitive riparian buffer acreage received "2" points; parcels with 2-7.99 acres of highly sensitive riparian buffer acreage received "1" point; parcels with <2 acres of highly sensitive riparian buffer acreage received "0" points.

GIS Layers Used: Parcel, Variable Width Riparian Buffer Model Results Layer (Inputs: DEM Raster Files, NLCD Land Cover 2011, National Wetlands Inventory, State Soil Survey Geographical Database, National Hydrography Dataset), 100-foot Waterway Buffer Layer

5) Forested Riparian Buffer Areas

Forested riparian buffers provide increased benefits to water resources and provide habitat benefits to terrestrial and aquatic species. Protecting forested areas within highly sensitive riparian buffer areas will ensure that forest cover and water quality benefits are not lost.

Scoring: Parcels that have overlap with both forested land cover (mixed, evergreen, and deciduous) and the Highly Sensitive Riparian Buffer Areas layer (8.1.4) received "1" point; all other parcels received "0" points.

GIS Layers Used: Parcel, Highly Sensitive Riparian Buffer Areas Layer (8.1.4), Forest Land Cover

6) Wetlands Classifications

A wetland is an area that is permanently or seasonally saturated with water, supports predominately hydric vegetation, and contains hydric soils. The ecological and environmental benefits of

wetlands include flood control, water purification, shoreline stabilization, groundwater recharge, and streamflow maintenance. FreshWater (FW)-Forested/Shrub, FW-Emergent, and Riverine wetlands are the highest functioning types of wetlands, providing the most water quality benefits.

Scoring: Parcels containing wetlands were assigned points based on the type of wetland present. Parcels with FW Forested/Shrub, FW Emergent, and Riverine wetlands (i.e., the classifications of higher value wetlands) received "3" points; parcels with FW pond and lake wetlands received "2" points; remaining parcels received "0" points.

GIS Layers Used: Parcel, National Wetlands Inventory

7) Hydric Soils

Hydric soils are defined by federal law as "soil that, in its undrained condition, is saturated, flooded, or ponded long enough during a growing season to develop an anaerobic condition that supports the growth and regeneration of hydrophytic vegetation" (USDA, 2013). While wetlands must have hydric soils, presence of hydric soil does not necessarily indicate presence of wetlands. Hydric soils favor the formation of wetlands, support groundwater recharge, help identify the presence and boundary of wetlands, and support the growth of important vegetation that can help with pollution dissipation (Mid Atlantic Hydric Soil Committee, 2011). Presence of hydric soils within parcels indicates the current/potential for ecological services that are important to protecting water quality.

Scoring: Point values were assigned based on the acreage of the parcel that contains hydric soils. Parcels with 50 or more acres hydric soils received "3" points. Parcels with 30-49.99 acres of hydric soils received "2" points. Parcels with 5-29.99 acres of hydric soils received "1" point. Parcels with 4.99 acres or less of hydric soils received "0" points.

GIS Layers Used**:** Parcel, State Soil Survey Geographical Database

8) 100-Year Floodplain

Floodplains help protect people and infrastructure from flooding and also benefit water quality by acting as natural filters as well as recharging aquifers (TNC, 2016). By protecting existing undeveloped floodplains, the ecological benefits provided to the river system can continue. Flooding can be increased by land development, which may increase stormwater runoff and velocity.

Scoring: The National Flood Hazard Layer represents the current effective flood risk within an area, depicting which areas have a 1% probability of occurring in any given year. Parcels that fall within the 100-year floodplain approved by the Federal Emergency Management Agency (FEMA) without any urban/developed land received "2" points; parcels within the 100-year floodplain with urban/developed land received "1" point; all other parcels received "0" points.

GIS Layers Used: Parcel, National Flood Hazard (FEMA), NLCD Land Cover (2011)

9) Source Water Protection Areas

The Safe Drinking Water Act of 1996 was amended to provide a greater focus on pollution prevention to ensure surface water and groundwater are protected from pollution. These amendments require states to provide Source Water Assessment Reports (SWAR) that contain important information about drinking water sources and their susceptibility to contamination and identify the areas that contribute to a surface-water intake, or Source Water Protection Areas (SWPA) (SCDHEC, 2018). Protecting SWPAs is crucial to protecting drinking water sources.

Scoring: Parcels within source water protection areas received "2" points; parcels outside source water protection areas received "0" points.

GIS Layers Used: Parcel, Source Water Protection Areas

10) Stream Length

Parcels containing more linear feet of streams offer the opportunity to better protect water quality.

Scoring: Parcels with streams along/within their boundary were analyzed to determine the average length of streams within parcels throughout the watershed. In the Three and Twenty Creek Watershed, the average stream length within/adjacent to a parcel is 0.013 miles. Parcels with above average stream length received "2" points; other parcels received "0" points.

GIS Layers Used: Parcel, National Hydrography Dataset

11) Adjacent to Existing Protected Land

Protecting larger areas can enhance the environmental benefits provided by existing protected lands. Examples of existing protected lands include national and state parks, conservation easements, heritage preserves, and water utility-owned properties. Environmental benefits can include reduced flooding and soil erosion, streambank stabilization, improved water and air quality, and habitat protection (Stolton, 2015). Existing protected land can be seen in Figure 9.

Scoring: Parcels that were adjacent to existing protected land received "1" point; parcels not adjacent to existing protected land received "0" points.

GIS Layers Used: Parcel, National Conservation Easement Database (Source: NCED), UF Conservation Easements, County Parks, National Heritage Preserves.

11) Parcel Size

Some land protection costs remain constant whether protecting a 200-acre or a 20-acre parcel. Since larger parcels generally provide increased environmental benefits, in many cases focusing on larger parcels will provide the most cost-effective option for protecting water quality.

Scoring: Parcels that meet UF's standard minimum acreage for conservation easements (50 acres) received "1" point; all other parcels received "0" points.

GIS Layers Used: Parcel, HUC-12 Watershed

Appendix F. Parcel Prioritization Criteria

Parcel Prioritization for Restoration BMPs

1) Sewer Service Availability

Parcels without access to sanitary sewer lines are most likely to use septic tank systems to treat wastewater produced on site. This criterion is a prerequisite to further analysis within the Septic BMP category. Parcels that have sewer systems are not eligible for septic system repairs and replacements and thus are excluded from further analysis.

Scoring: Parcels without sewer lines received "1" point; all other parcels received "0" points.

GIS Layers Used: Parcel, Local Sewer System Lines (Provided by Water Districts)

Restoration Categories: Septic System Repair or Replacement

2) Adjacency to Reservoirs and Drinking Water Intakes

Improperly operating septic systems directly adjacent to water, especially drinking water sources, are of the most concern because bacteria have less opportunity to settle or naturally filter before reaching a waterway. As such, parcels with septic systems that are directly adjacent to drinking water sources or other waterways were prioritized.

Scoring: Parcels (likely to have septic systems) that are adjacent to drinking water intakes or reservoirs received "4" points. Parcels that are adjacent to any waterways [other than drinking water intakes or reservoirs] received "2" points; all other parcels received "0" points.

GIS Layers Used: Parcel, National Hydrography Dataset, Drinking Water Intakes

Restoration Categories: Septic System Repair or Replacement

3) Current Water Quality Impairments

Parcels including, directly adjacent to, or upstream of an existing known bacterial impairment could be contributing to the problem.

Scoring: Parcels including, adjacent to, or upstream of streams with existing bacteria water quality impairments received "3" points. All other parcels received "0" points.

GIS Layers Used: Parcel, 303(d) List of Impaired Waters (2016), National Hydrography Dataset

Restoration Categories: Septic System Repair or Replacement, Wetland Restoration/ Enhancement, Riparian Buffer Restoration/Enhancement, Voluntary Dam Removal, Stormwater BMPs

4) Land Cover

- Parcels within urban and developed lands are more likely to have the opportunity to connect to sewer systems and reduce the potential for bacterial contamination. While switching from septic to sewer is not always a viable option, the potential is greater in

urban areas; this criterion helps to identify areas that could most benefit from such a switch.

- Agricultural lands directly adjacent to waterways are more likely to contribute bacteria, nutrients, and sediment when stormwater runoff carries fertilizer and animal waste directly into streams. This criterion is a prerequisite to further analysis within the Agricultural BMP category; parcels that do not have agricultural land cover are not eligible for agricultural BMPs and are excluded from further analysis. Parcels must either have 50% or greater agricultural land cover or have any percentage of agricultural land cover adjacent to streams; parcels must meet one or both of these criteria to be considered for further analysis.
- Various land activities, such as logging and urban development, can negatively impact water quality through increased stormwater runoff, pollutant loads, stream channelization, and increased flooding (Frankenburger, n.d.). This factor identifies parcels with urban lands or known logging operations that are likely contributing higher pollutant loads and where BMP implementation may provide water quality benefits.

Scoring:

- *Septic System Repair or Replacement*: Parcels that fall within urban/developed land received "2" points; all other parcels received "0" points
- *Agricultural BMPs:* Parcels with 50% or more agricultural land cover (identified as pasture/hay and cultivated crops) received "2" points. Parcels with agricultural lands that are adjacent to streams or include a water impoundment received "2" points. Parcels with 50% or greater agricultural land that are adjacent to streams or include a water impoundment received "4" total points. All other parcels received "0" points.
- *Stormwater BMP's*: Parcels within urban/developed land areas received "2" points. Parcels with known logging operations received "1" point; all other parcels received "0" points.

GIS Layers Used: Parcel, National Land Cover Dataset (2011), Landowner Database

Restoration Categories: Septic System Repair or Replacement, Agricultural BMPs, Stormwater BMPs

5) Current Pollutant Export

This criterion prioritizes parcels likely to have high levels of nitrogen, phosphorus, and sediment export by using the results from Furman University's InVEST Model results.

Scoring: For each pollutant (nitrogen, phosphorus, and sediment) the average value of exports within each parcel was calculated; the range of averaged values was then separated into high, medium, and low export categories. For each pollutant, parcels within the highest average range of export received "3" points; parcels within the medium range of export received "2" points; parcels within the low range/no export received "0" points.

Current Pollutant Export Priority Ranges

Pollutant	Units	Low Priority	Medium Priority	High Priority
Nitrogen	Kg/pixel/year	0 – 0.032488	0.0324489 – 0.128093	0.128094 – 0.409430
Phosphorus	Kg/pixel/year	0 – 0.001163	0.001164 – 0.036652	0.036653 – 1.119240
Sediment	tons/pixel/year	0	0.000001 – 0.000004	0.000005 – 0.001241

GIS Layers Used: Parcel, Furman University's Current Pollutant Export Layers for Nitrogen, Phosphorus, and Sediment (results from the InVEST Model)

Restoration Categories: Agricultural BMPs, Wetland Restoration/Enhancement, Riparian Buffer Restoration/Enhancement, Shoreline Management, Stormwater BMPs

6) Unpermitted Point Source Pollutants

Although under the threshold for a permit, some point source activities may contribute to water quality pollution through stormwater runoff, such as existing agricultural operations (i.e., use of fertilizers, chemicals, or land applications of manure or waste).

Scoring: Parcels identified as including agricultural operations (farms) below the NPDES permit threshold received "1" point; all other parcels received "0" points.

GIS Layers Used: Parcel, Google searches: Farms, Golf Courses, Car Lots/Washes, Gas Stations, and Dry Cleaners

Restoration Categories: Agricultural BMPs, Stormwater BMPs

7) Permitted Point Source Pollutants

Permitted agricultural point sources could be contributors to bacteria, nutrient, or sediment pollution and may benefit from installation of agricultural BMPs.

Scoring:

- *Agricultural BMPs:* Parcels with agricultural points source permits (e.g., CAFOs, Animal Management Areas, biosolid application areas, known farms) received "1" point. All other parcels received "0" points.
- *Stormwater BMPs:* Parcels with NPDES (non-agricultural), mines/gravel pits, landfills, etc. received "1" point. All other parcels received "0" points.

GIS Layers Used: Parcel, Agricultural and Non-Agricultural NPDES, Land Applications, Animal Management Areas, Biosolid Application Areas, known farms (Google Search), Landfills, Mines/Gravel Pits

Restoration Categories: Agricultural BMPs, Stormwater BMPs

8) Restorable Wetlands

A wetland is an area that is permanently or seasonally saturated with water, supports predominately hydric plants, and contains hydric soils. The ecological and environmental benefits of wetlands include flood control, water purification, shoreline stabilization, groundwater recharge, and streamflow maintenance (WA Dept. of Ecology, 2017). Restoring inundated and modified wetlands to their natural states would provide significant environmental and water quality benefit (US EPA, 2002).

Scoring: Parcels with wetlands with special modifiers (excavated, spoil, artificial substrate, diked/impounded, managed, farmed, partially drained/ditched, beaver) received "2" points. Additionally, parcels with historic wetlands received an additional "2" points.

GIS Layers Used: Parcel, National Wetland Inventory (Current and Historical)

Restoration Categories: Wetland Restoration/Enhancement

9) Water Impoundments and Dams

Dams physically alter the aquatic ecology and often convert natural wetlands into open water, reducing ecological benefits. Removal of obsolete dams can restore natural wetlands and stream flow, improve aquatic habitat, and renew natural sedimentation levels. Removing dams is not always a viable, or preferred, option depending on the dam's use, condition, and owner's interests.

Scoring: Parcels with dams received "2" points; all other parcels received "0" points.

GIS Layers Used: Parcel, National Inventory of Dams

Restoration Categories: Voluntary Dam Removal, Wetland Restoration/Enhancement

10) Highly Sensitive Riparian Buffer Areas

Riparian, or vegetated, stream buffers provide water quality benefits including slowing and filtering stormwater runoff, reducing flooding, preventing stream channelization, stabilizing streambanks, shading streams, and minimizing erosion (Pennsylvania Land Trust Association, 2014) . This criterion places priority on parcels with highly sensitive riparian buffers that, if enhanced or restored, would provide significant water quality benefits.

Scoring: UF identified highly sensitive riparian areas by combining the results from the USFS Riparian Buffer Delineation Model v.5.2 (www.riparian.solutions, run by UF) with a 100-foot buffer around all waterways (Abood et al., 2012 a, b). Parcels were assigned points according to acreage of highly sensitive riparian buffer areas within each parcel, based on the "natural breaks" in the resulting acreage data (partitioning data into classes based on natural groups in the data distribution). Parcels that fell fully or partially within this layer were assigned "4" points; all other parcels were assigned "0" points (Fischer, 2000). This criterion is a prerequisite for further analysis.

GIS Layers Used: Parcel, Variable Width Riparian Buffer Model Results Layer (Inputs: DEM

Raster Files, NLCD Land Cover 2011, National Wetlands Inventory, State Soil Survey Geographical Database, National Hydrography Dataset), 100-foot Waterway Buffer Layer

Restoration Categories: Riparian Buffer Restoration/Enhancement, Shoreline Management

11) Stream Order

Priority was given to parcels along first and second order streams to account for the enhanced benefits riparian buffers provide on smaller, higher order streams.

Scoring: Using the National Hydrology Dataset, parcels containing headwater (first or second order) streams received "4" points. All other parcels received "0" points.

GIS Layers Used: Parcel, National Hydrology Dataset

Restoration Categories: Riparian Buffer Restoration/Enhancement

12) Adjacency to Drinking Water Reservoirs or Drinking Water Intakes

Parcels directly adjacent to waterways and drinking water sources are more likely to contribute to pollutant loading, as there is less opportunity for filtration or removal before reaching surface and groundwater.

Scoring: Parcels adjacent to drinking water intakes or reservoirs received "4" points. Parcels adjacent to any waterways (other than drinking water intakes or reservoirs) received "2" points; all other parcels received "0" points.

GIS Layers Used: Parcel, National Hydrography Dataset, Drinking Water Intakes

Restoration Categories: Riparian Buffer Restoration/Enhancement, Shoreline Management

13) 100-Year Floodplain

Floodplains help protect people and infrastructure from flooding and also benefit water quality by acting as natural filters and recharging aquifers(Natural Capital Project, 2017). Impacts from flooding events are exacerbated by land development, which increases stormwater runoff volume and velocity. Restoring existing undeveloped floodplains return ecological benefits to the river system and downstream communities.

Scoring: The National Flood Hazard Layer represents the current effective flood risk within an area, depicting which areas have a 1% probability of flooding in any given year. Parcels that contain areas within the 100-year floodplain approved by the Federal Emergency Management Agency (FEMA) received "2" points; all other parcels received "0" points.

GIS Layers Used: Parcel, National Flood Hazard (FEMA), NLCD Land Cover (2011)

Restoration Categories: Riparian Buffer Restoration/Enhancement

14) Private Boat Ramps and Docks
Existing private boat ramps and docks can cause increased stormwater runoff, increased pollutants from boat fuel, sedimentation, and more.

Scoring: Parcels with private boat ramps along drinking water reservoirs received "2" points; parcels with private docks along drinking water reservoirs received "1" point. All other parcels received "0" points. A parcel with both a private boat ramp and a private dock received "3" total points: "2" for a private boat ramp and "1" for a private dock.

GIS Layers Used: Parcel, Private Boat Ramps and Docks

Restoration Categories: Shoreline Management

15) High Traffic Commercial Pet Locations – Some locations are more likely to have more dog traffic; if pet waste is not properly disposed of, these areas are at increased likelihood of contributing to water quality pollution through stormwater runoff that includes concentrated levels of pet waste.

Scoring: Parcels containing veterinary hospitals, pet stores, pet grooming or boarding facilities, or humane societies/animal shelters received "1" point; all other parcels received "0" points.

GIS Layers Used: Parcel, Google searches: Veterinary Hospitals, Pet Stores, Pet Grooming and/or Boarding Facilities, Animal Shelters.

Restoration Categories: Pet Waste Stations

16) Parks – Existing public land where people may take their dogs include parks and heritage preserves. If not properly disposed of, pet waste negatively impacts water quality by increasing bacteria levels.

Scoring: Parcels categorized as existing public land (National/State/County/City Parks, Heritage Preserves, other lands open to the public) received "1" point. All other parcels received "0" points.

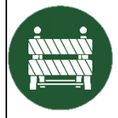
GIS Layers Used: Parcel, National/State/County/City Parks, Heritage Preserves

Restoration Categories: Pet Waste Stations

BMP	Impairments Addressed	Sources of Pollution	Target Audience(s)	Messages	Methods of Outreach	Potential Project Partners
Septic System Repair/Replacement	• Bacteria • Nutrients (Nitrogen and Phosphorus)	• Leaking/failing septic systems	• Homeowners • Home Owner Associations (HOAs) • Certified Septic System Contractors • Local Wastewater Providers • Municipal staff	• Septic systems can pollute waterways and are a threat to human health. Damaged or failing septic systems can expose citizens to harmful bacteria and viruses through contaminated drinking water and sewage backups in a home's indoor plumbing. • Faulty septic systems can cause untreated wastewater to rise to the surface of leach fields and drain into nearby waterways polluting surface waters. • Routine inspections and maintenance of septic systems are important to keep them operating properly.	• Mail letters to homeowners • Information displays and/or brochures at public libraries, City/Town Halls, ARJWS and other water utility offices, Clemson Extension offices, County Buildings, and recreational facilities. • Utility bill stuffers.	• Town of Pendleton • Anderson County • City of Anderson • ARJWS • Anderson County Library System
Agricultural BMPs	• Bacteria • Nutrients (Nitrogen and Phosphorus) • Sediment	• Livestock with access to streams • Croplands	• Landowners • Agricultural Operators/ Livestock Owners • Farm Bureaus • SC Cattlemen's Association • Carolina Farm Stewardship Association	• It is important to keep animals out of waterways because it improves herd health while also protects water quality • Riparian buffers are effective at reducing soil erosion and the amount of bacteria, sediments, and nutrients entering streams from animal waste. • Proper use of fertilizers is important to protect water quality (in appropriate amounts and not before or during rain events). • Livestock can cause streambanks to erode and contribute to the sedimentation of waterways.	• Mail letters to landowners • Informational displays and/or brochures about proper agricultural practices at City Halls, Water District offices, County Buildings, NRCS and SWCD offices. • Provide information on BMP cost share programs for inclusion in SWCD and Cattlemen's Association webpages, and newsletters.	• Clemson Extension • NRCS • Anderson County Soil and Water Conservation District • Anderson County • Pickens County
Wetland and Riparian Buffer Restoration and Enhancement	• Nutrients (Nitrogen and Phosphorus) • Sediment	• Impacted, low quality, or inundated wetlands • Eroded streambanks	• Homeowners • HOAs • Municipal Staff • Mitigation Projects	• Plant native plants along creeks/streams to prevent erosion. • Establish a buffer ordinance with Anderson County/municipalities to depict buffer width requirements. • Increase density of forested riparian buffers by planting trees along/nearby stream banks.	• Utility bill stuffers • Informational brochures and posters at local public offices. • Host a public tree or native plant giveaway for homeowners. • Establish support for a county-wide riparian buffer ordinance.	• Clemson Extension • Anderson and Pickens County Stormwater Partners • ARJWS • Lake Hartwell Association • Municipal and County Staff

BMP	Impairments Addressed	Sources of Pollution	Target Audience	Messages	Methods of Outreach	Potential Project Partners
Stormwater BMPs	• Bacteria • Nutrients (Nitrogen and Phosphorus) • Sediment	• Stormwater Runoff	• Homeowners • HOAs • Public Schools Local community groups (e.g. YMCAs) • Municipal staff	• Sweep off sidewalks and driveways. • Use weed-free mulch when reseeding bare spots on lawns, and use erosion control blankets if restarting or tilling a lawn. • Notify local government officials when you see sediment entering streets or streams near a construction site. • Avoid mowing within 10 to 25 feet from the edge of a stream or creek. • Wash your car at a commercial car wash or on a surface that absorbs water, such as grass or gravel. • Do not dump waste down storm drains because water flowing into storm sewers usually drains directly into local waterways without treatment. • Riparian buffers protect streams by reducing erosion and reducing pollutants entering streams.	• Do PSAs about stormwater runoff and water quality on local radio stations. • Maintain a presence at local festivals. • Help promote watershed education in the public-school system. • Promote online educations resources related to water quality (Clemson Ext, City and County websites, and local SWCDs). • Informational brochures and posters at local public offices (e.g., Clemson Ext., NRCS, SWCDs).	• Anderson and Pickens SWCD • Municipal and County Staff • Clemson Extension • Anderson & Pickens County Stormwater Partners • Lake Hartwell Association • Anderson County Public Works • Anderson County Parks Dept. • Municipal Staff
Pet Waste Stations	• Bacteria	• Improper disposal of pet waste	• Homeowners • HOAs • Apartment complexes • Veterinary offices • Animal shelters • Animal groomers	• It is important to properly dispose of pet waste! The improper disposal of pet waste is a major threat to water quality because it contains high levels of bacteria, parasites, and viruses. High levels of bacteria are a threat to human health if ingested. High bacteria levels are also more difficult to treat for drinking water providers.	• Pet waste station and signage installations • Informational posters at veterinary offices, groomers, kennels, animal shelters, libraries, city halls, and local schools. • Provide dog waste bag holders to veterinary offices, groomers, kennels, and animal shelters. • Advocate for the adoption of pet waste ordinances in local municipalities and counties.	• Anderson County Public Works • Anderson County Parks Dept. • Anderson County Soil and Water District • Municipal Staff • Clemson Extension • Anderson & Pickens County Stormwater Partners
Shoreline Management	• Nutrients (Nitrogen and Phosphorus) • Sediment	• Eroded shorelines • Improper boat dock maintenance	• Homeowners • HOAs • Water utilities • Reservoir Operators	• Plant native plants along shoreline to prevent erosion. • Avoid mowing to water's edge to reduce runoff into local waterways. • Establish a 10-30 foot no fertilizer or pesticide zone along shorelines or rivers, streams, and lakes. • Avoid pruning vegetation along shoreline without seeking proper guidelines and permits. • Obtain proper permits and abide by permit requirements.	• Utility bill stuffers • Informational brochures and posters at local public offices. • Host trainings and workshops on shoreline management for homeowners.	• Anderson/Pickens County SWCD • Municipal and County Staff • Clemson Extension • Anderson & Pickens County Stormwater Partners • Lake Hartwell Association • Utilities – ARJWS • USC Upstate Watershed Ecology Center

BMP	Impairments Addressed	Sources of Pollution	Target Audience	Messages	Methods of Outreach	Potential Project Partners
Wildlife BMPs	• Bacteria • Nutrients (Nitrogen and Phosphorus) • Sediment	• Canadian Geese • Beavers • Deer • Coyotes • Feral Hogs	• Homeowners • HOAs • Apartment complexes • Land owners • Municipal staff • Hunt Clubs • Sporting Goods Stores	• Animal waste from wildlife contributes to bacteria pollution in rivers, lakes, and streams. • Discourage nuisance wildlife species from congregating in areas near impaired waters by planting riparian vegetation and posting not feeding signage.	• Host workshops on how to control Canadian Geese, beaver, deer, and feral hogs populations. • Promote signage in public areas with message "Don't Feed the Geese". • Create informational flyers on wildlife for displays at local city halls, libraries, community centers, etc.	• Clemson Extension • Local NRCS offices • Local Soil and Water Conservation Districts • Anderson and Pickens Counties Parks Dept. • SCDNR
Land Protection	• Bacteria • Nutrients (Nitrogen and Phosphorus) • Sediment	Protection Strategies: • Conservation Easement • Deed Restriction • Fee Simple Purchase • Land Donation • Water Utility Funded Watershed Protection Programs	• Landowners • Homeowners • SC Cattlemen's Association • Carolina Farm Stewardship Association	• Voluntary conservation easements can protect the land you love while you continue to own and manage it for traditional uses; you may also realize significant tax benefits. • Conservation agreements typically prevent land uses such as residential subdivisions, commercial or industrial operations, and mining, while allowing traditional rural land uses, such as farming, grazing, hunting, and timbering to continue.	• Send letters to high priority landowners with information about conservation easements. • Provide information on conservation easements for inclusion in SWCD and Cattlemen's Association webpages, and newsletters. • Host public outreach meetings with Land Trust staff targeting landowners with large tracts of land, working farms, etc.	• ARJWS • Clemson Extension • SC Farm Bureau • SC USDA • SC Cattlemen's Association • SCDNR
Silviculture	• Sediment	• Improper forest management • Streamside timber harvesting • Poorly placed and managed access roads	• Landowners • Foresters	• Improper forestry practices can degrade water quality. • Avoid any forestry activities in streamside management zone. • Harvesting operations should be planned and executed with the goal to protect the site. • Roads should be constructed in a manner to prevent stream crossings and steep slopes to the best extend possible. • Sites should be prepped and restored to prevent erosion.	• Provide information to landowners with forestry operations. • Put informational brochures at local public offices.	• Clemson Extension • Anderson & Pickens Counties Public Works • Anderson & Pickens Counties Stormwater Partners

 Construction	• Sediment	• Land clearing • Road building • Residential construction • Commercial construction	• Home Builder Associations • Engineers • Contractors	• Contractors should install sediment control devices according to specifications. • Contractors should abide by local stormwater regulations. • Large tracts of cleared lands should be stabilized to prevent erosion. • Conservation easements are tools that can be used to protect land while providing financial benefits to landowners and water quality benefits to the region.	• Provide information on proper stormwater protection to local contractors through stormwater permitting departments. • Host trainings and workshops on sediment control practices for those in construction industry. • Place informational displays at local municipal buildings where building permits are issued.	• Anderson County Public Works • Pickens County Stormwater • City of Anderson Stormwater Department • Anderson & Pickens County Stormwater Partners

UPSTATE FOREVER

PUBLIC MEETING NOTICE

Cleaning Up Three & Twenty Basin Waterways

November 29, 2018, 6:00-7:30 pm at Anderson Regional Joint Water System

998 Hunters Trail, Anderson, SC 29625

Upstate Forever and partners have scheduled a public meeting to discuss the "Three and Twenty River Watershed Based Plan," a grant funded project targeting bacteria, sediment, and nutrient pollution in the Three and Twenty Watershed rivers. This watershed based plan provides a comprehensive overview of the sources of bacteria, sediment, and nutrient pollution in these watersheds and identifies critical areas for restoration and protection. The plan will also provide strategies to reduce or eliminate pollution loads within watersheds.

The public is encouraged to attend to learn more about this process and provide important feedback. For more information, contact Erika Hollis at **ehollis@upstateforever.org**.

PARTNERS

ANDERSON REGIONAL JOINT WATER SYSTEM

ANDERSON & PICKENS COUNTIES stormwater PARTNERS
A CLEMSON EXTENSION SERVICE

PICKENS COUNTY SOUTH CAROLINA 1868

This project is funded wholly or in party by the US EPA under a Capitalization Grant for Drinking Water State Revolving Funds through the SC Department of Health and Environmental Control (SC DHEC).